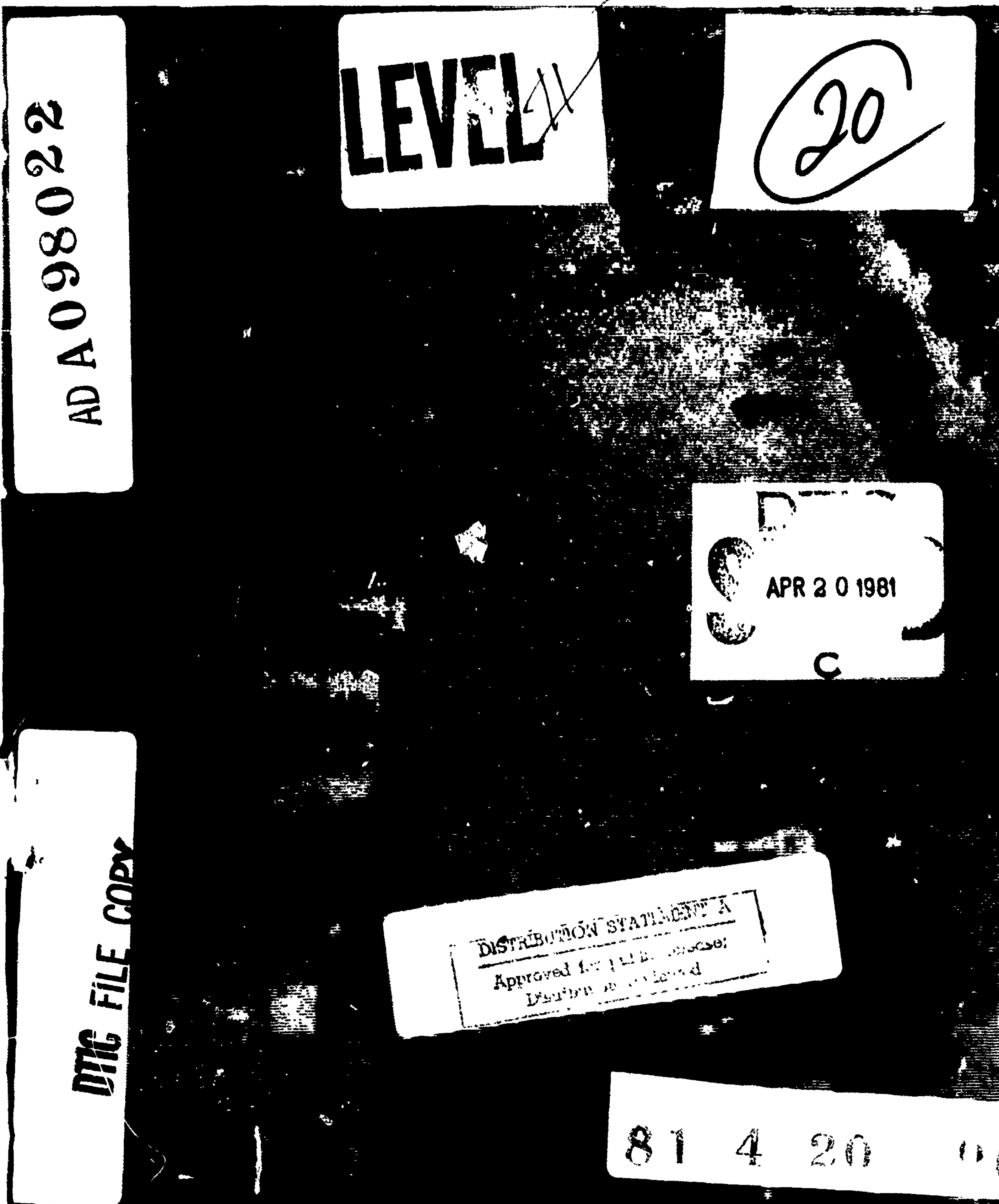
US Army Corps of Engineers
Baltimore District

Susquehanna River Basin Flood Control Review Study



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DEPARTMENT OF THE ARMY
NORTH ATLANTIC DIVISION, CORPS OF ENGINEERS
90 CHURCH STREET
NEW YORK, NEW YORK 10007

27 October 1980

NOTICE OF REPORT
SUSQUEHANNA RIVER BASIN FLOOD CONTROL REVIEW STUDY
NEW YORK, PENNSYLVANIA, MARYLAND

The District and Division Engineers have completed a report on flood protection for the Susquehanna River Basin, New York, Pennsylvania and Maryland. The report is in response to resolutions adopted by the Public Works Committees of the United States Senate and House of Representatives, dated 7 July 1972 and 12 October 1972, to determine the advisability of adopting further improvements to the existing flood control system in view of the heavy damages and loss of life caused by Tropical Storm Agnes in June 1972. Public meetings were held at several locations in the Basin during the summer and fall of 1976. A public information pamphlet summarizing the study and its findings was published in September 1980.

Investigations were made of various structural and non-structural solutions to problems in flood prone areas on the main stem and the major tributaries of the Susquehanna River. These have resulted in the identification of potential projects which warrant further study. These projects include increasing the level of protection of the existing projects in Binghamton, New York and Williamsport and South Williamsport, Pennsylvania, and providing non-structural projects in the Towns of Conklin, Kirkwood and Erwin, New York.

Further study of Binghamton and the non-structural projects is currently underway. The Williamsport study has been authorized by Congress and will commence upon funding by Congress.

Further information may be obtained from the District Engineer, U.S. Army Engineer District, Baltimore, Corps of Engineers, P.O. Box 1715, Baltimore, Maryland 21203. Mr. Harry E. Kitch of the Baltimore District is available to answer questions at (301) 962-2530. Interested parties may purchase copies of the report from the District Engineer at a cost of $3.00 per copy. Check or money orders should be made payable to "Treasurer of the United States."

You are requested to give the foregoing information to any persons known by you to be interested in the report, and who, not being known by the Division Engineer, have not received a copy of this public notice.

John E. Wagner
JOHN E. WAGNER
Colonel, CE
Acting Division Engineer

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Susquehanna River Basin Flood Control Review Study reports on data compiled from investigation of flood prone areas in the Basin and presents a broad view of the overall study. Its purpose is to provide water resource planners, scientists and other interested parties with information on potential flood control improvements.

Included in the report are results of preliminary studies and reviews made to determine the feasibility of flood control improvements for areas in the Basin

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with significant flood problems. The Study reviews prior reports and their recommendations to determine if revisions should be made and seeks to identify those projects that warrant further detailed study. It also identifies feasible plans for reduction of flood damage within the Study area.

In addition, the report presents information on the flood history of the area, its available natural resources, socio-economic history, sources of water and power supply, and recreational opportunities.

The Federal and State agencies that participated in the Study, with and under the direction of the Baltimore District, Corps of Engineers, prepared the sections of the report that fall under their area of expertise.

(1)

SUSQUEHANNA RIVER BASIN
FLOOD CONTROL REVIEW STUDY

August 1980

BALTIMORE DISTRICT
U.S. ARMY CORPS OF ENGINEERS

SYLLABUS

The Susquehanna River Basin Flood Control Review Study was initiated by the Resolutions adopted by the Public Works Committees of the United States Senate and House of Representatives, dated 7 July 1972 and 12 October 1972, to determine the advisibility of adopting further improvements to the existing flood control system in view of the heavy damages and loss of life caused by Tropical Storm Agnes in in June 1972. Investigations were made of various structural and nonstructural solutions to problems in flood prone areas on the main stem and the major tributaries of the Susquehanna River. These have resulted in the identification of six potential projects which warrant further study. These potential projects include the raising of two existing local flood protection projects and non-structural projects in four other areas. In addition to the specific projects investigated, an evaluation of the existing flood forecasting and warning system was performed by an interagency task force and recommendations were formulated to improve the system.

SUSQUEHANNA RIVER BASIN FLOOD CONTROL REVIEW STUDY

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SUSQUEHANNA RIVER BASIN FLOOD CONTROL REVIEW STUDY

Introduction

PURPOSE AND AUTHORITY

The purpose of the study is to review prior reports and their recommendations including those made by the Susquehanna River Basin Coordinating Committee as presented in their June 1970 report, to determine if revisions should be made and to identify implementable plans for the reduction of flood damage within the Susquehanna River Basin.

Until 1960, the various Federal and State agencies made surveys and studies of the Susquehanna River and its tributaries that were limited in their purposes. These reports dealt only with the specific resource that concerned the authorizing agency. A need existed for a comprehensive report on the water and related land resources of the Susquehanna River Basin.

On October 5, 1961, the Senate Committee on Public Works adopted a resolution directing that a study of the Susquehanna River Basin be made in order to develop a comprehensive plan for the water and related land resources of the Basin in the States of New York, Pennsylvania, and Maryland. The study was requested by Senator Joseph S. Clark of Pennsylvania and the Resolution adopted states:

> "Resolved by the Committee on Public Works of the United States Senate, That the Board of Engineers for Rivers and Harbors, created under Section 3, of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report of the Chief of Engineers on the Susquehanna River and tributaries, New York, Pennsylvania, and Maryland, published as House Document Numbered 702, Seventy-seventh Congress, and other reports, with a view to providing a comprehensive plan for the development of the water and related land resources of the Susquehanna River Basin in the States of New York, Pennsylvania, and Maryland, in the combined interest of flood control, navigation, water supply, recreation, pollution abatement, and other beneficial water uses."

Additional authorization requested by Representative Daniel Flood of Pennsylvania was provided by similar resolution of the House Committee on Public Works, adopted May 10, 1962, which states:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of the Engineers for Rivers and Harbors be, and is hereby, requested to review the report on the Susquehanna River, New York, Pennsylvania, and Maryland, published as House Document Numbered 702, Seventy-seventh Congress, and other pertinent reports with a view to determining whether improvements for flood control and water resource needs in the Susquehanna River Basin are advisable at this time."

The comprehensive study of the Susquehanna River Basin combining the above resolutions and five other outstanding resolutions, was completed in June 1970. In view of the extensive damage and loss of life caused by the flood of June 1972, the need arose for a review of the Susquehanna River Basin Study in order to determine whether any modifications of the flood control recommendations made in that report would be advisable. The Senate Committee on

Public Works, at the request of Senator Richard S. Schweiker of Pennsylvania adopted a Resolution on 7 July 1972, which states:

> "Resolved by the Committee on Public Works of the United States Senate, That the Board of Engineers for Rivers and Harbors, created under Section 3, of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the Report of the Chief of Engineers on the Susquehanna River and Tributaries, New York, Pennsylvania, and Maryland, published as House Document Numbered 702, Seventy-seventh Congress, and other reports in order to determine generally whether any modifications of the recommendations contained therein are advisable and specifically to determine the advisability of adopting further improvements for flood control and allied purposes in view of the heavy damages and loss of life caused by the hurricane flood of June 1972, with a view to preparing a comprehensive plan for the development of the water resources of the Susquehanna River Basin in the States of New York and Maryland and the Commonwealth of Pennsylvania in the combined interest of flood control, water supply, recreation, pollution abatement, and other beneficial water uses."

Additional authorization was provided by a similar resolution of the Committee on Public Works of the House of Representatives at the request of Representative Daniel J. Flood of Pennsylvania, on October 12, 1972, which states:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Susquehanna River and tributaries, New York, Pennsylvania and Maryland, published as House Document Numbered 702, Seventy-seventh Congress, and other reports, with a view to providing a comprehensive plan for the development of the water and related land resources of the Susquehanna River Basin the States of New York, Pennsylvania and Maryland, in the combined interest of flood control, water supply, recreation, pollution abatement, and other beneficial water uses, with particular emphasis on flood control."

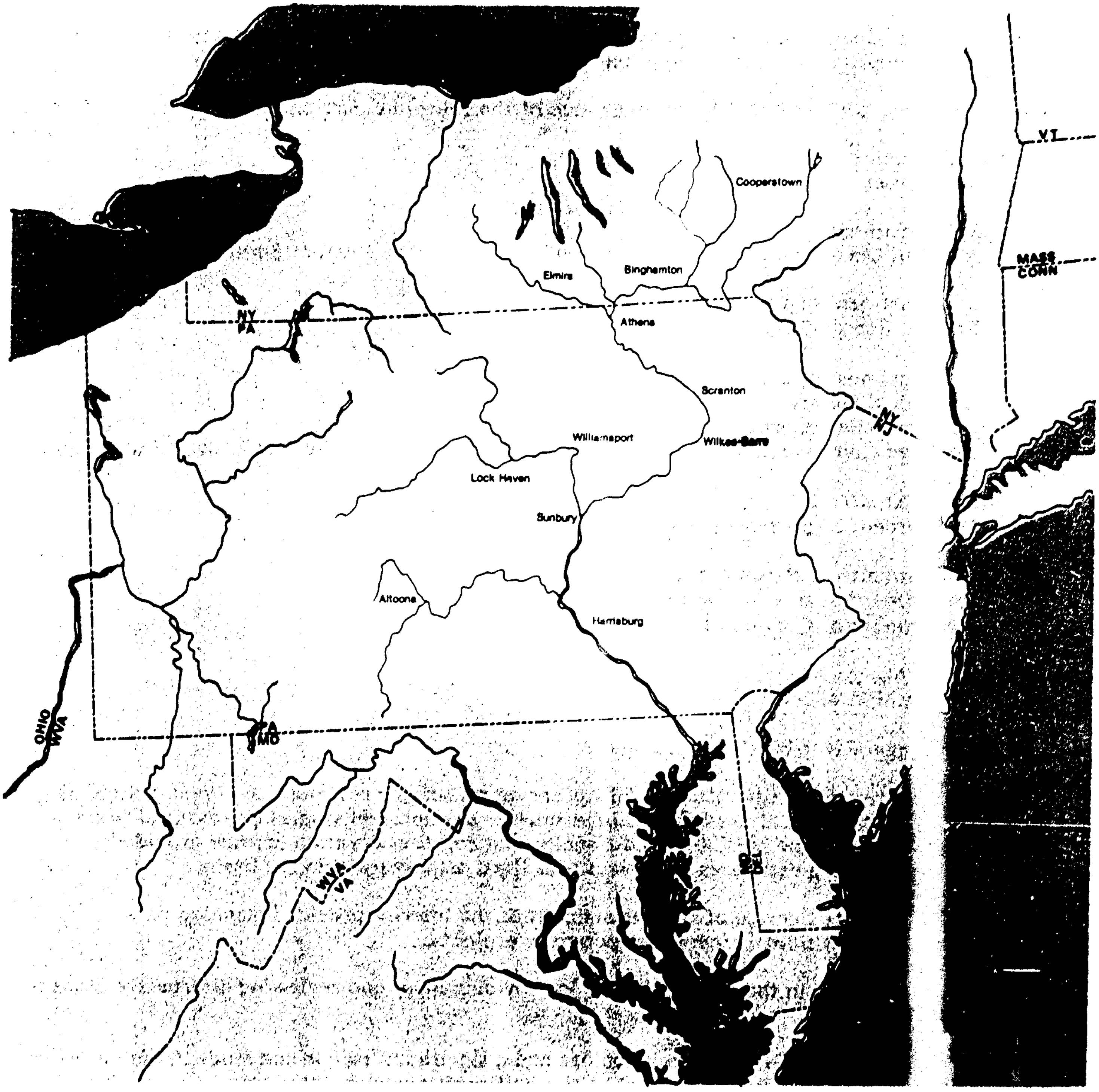
The comprehensive review study combining the above authorities was started in December 1974 with the goal of identifying and evaluating alternative approaches to reducing flood damages in the Susquehanna Basin.

SCOPE OF THE STUDY

The study area shown in Figure 1 includes the Susquehanna River Basin in the states of New York and Maryland and the Commonwealth of Pennsylvania. Studies were made in the interest of flood damage reduction and related purposes.

The flood prone communities within the basin on the main stem and major tributaries were reviewed to determine if modification of existing projects or new flood control measures would be feasible for implementation as Federal projects. A number of alternative structural and nonstructural measures for meeting basin needs were evaluated in varying degrees of detail. Those elements identified as being responsive to identified needs and exhibiting the greatest potential for development of feasible plans were evaluated in greater detail.

Various segments of this study were conducted and completed at different times since study initiation in 1974. The decisions reached on these segments were based on the data used at that time. The data and level of detail used are considered appropriate for this type of review study. The decisions reached in various segments are, therefore, considered to be sound and to reflect conditions in the basin. This report reflects the data and decisions made at various


Cooperstown
Elmira
Binghamton
Athens
Scranton
Williamsport
Wilkes-Barre
Lock Haven
Sunbury
Altoona
Harrisburg
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PA
VT
MASS
CONN
NY
NJ
OHIO
W.VA
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Figure 1

times during the study. The conclusions reached at the early part of the study are not considered to be sensitive to any changes which have occurred during the study and are still valid.

STUDY PARTICIPANTS AND COORDINATION

Study Participants

The Corps of Engineers had the responsibility for conducting and coordinating the study, plan formulation, consolidating data from other sources and preparing the report.

The studies were performed with the assistance of the following participating agencies:

U.S. Department of Agriculture,
Soil Conservation Service

U.S. Department of Commerce
National Oceanic Atmospheric Administration, National Weather Service

U.S. Department of Energy
Federal Energy Regulatory Commission

U.S. Department of Interior
Geological Survey
Fish and Wildlife Service
Heritage Conservation and Recreation Service (formerly Bureau of Outdoor Recreation)

State of New York
Department of Environmental Conservation

Commonwealth of Pennsylvania
Department of Environmental Resources
Department of Community Affairs

State of Maryland
Department of Natural Resources

Susquehanna River Basin Commission

The U.S. Department of Agriculture, Soil Conservation Service reviewed the flood control needs in the upstream portions of the basin to determine if any detailed studies of potential flood control projects would be feasible. Additionally, the Soil Conservation Service provided assistance by updating estimates of agricultural flood damages within the basin.

The Fish and Wildlife Service of the Department of the Interior provided planning data concerning fish and wildlife aspects for potential projects.

The role of the states in the study has been in providing input and reviewing alternative plans of improvement.

The Susquehanna River Basin Commission has had a significant role in the study in both a review and assistance capacity. At the request of the Baltimore District, the Commission chaired an interagency task force committee to study the existing flood forecasting and warning system and to recommend improvements. Other agencies forming the committee include:

The U. S. Geological Survey
The National Weather Service
Pennsylvania Department of Environmental Resources
Pennsylvania Division of Civil Defense
New York State Department of Environmental Conservation
New York State Division of Naval and Military Affairs
Maryland Department of Natural Resources
Maryland Civil Defense

The Federal Power Commission (now Federal Energy Regulatory Agency) participated in the study by providing data concerning hydroelectric power production potential at reservoir sites in the basin.

Coordination

In an effort to involve the public in the planning process, an effort has been made as part of this study to coordinate with concerned persons, groups, and agencies, provide them with relevant information, and receive feedback for consideration as the study progresses. At all times, the lines of communication have been kept open to encourage a free exchange of ideas, to answer pertinent questions, and to receive comments. Though the public is defined as any non-Corps of Engineers entity, it has been necessary to accomplish the coordination through two groups, agencies with an interest in flood control planning and the affected local public. The coordination activities and public meetings are discussed in the Public Views section.

THE REPORT

This report presents the results of the basin wide study of potential flood control improvements. All discussions presented herein lead up to the point of initiating detailed studies of those potential projects within the basin which appears to be feasible for Federal implementation.

The report is a technical presentation of the preliminary studies and reviews made of locations within the scope of the study and presents a broadview of the overall study. Included in the report is a description of the basin resources and economy; problems and needs; the evaluation and formulation of components of a basin plan and a detailed description of those components which have been identified as potentially meeting the criteria for Federal implementation.

The plan formulation portion consists of a description of the methods used to evaluate and screen the alternatives in the basin and identify those which warrant further study. Included also in this section are the results of the preliminary evaluations of feasibility of flood control improvements made of all locations in the basin with significant flood problems and identification of those projects which warrent further, more detailed study.

PREVIOUS FLOOD CONTROL STUDIES AND REPORTS

The flood of 1889 caused widespread damage in the entire Susquehanna River Basin and was a major flood in much of the West Branch Basin. Flood control measures were analyzed on the West Branch in a Corps of Engineers' Survey Report which appears as House Document 136, 51st Congress, 2nd Session (January 1891). Because of the large number of local flood protection projects necessary and the fact that navigation would not be improved on the West Branch, the Corps recommended that no action be taken by the Federal Government for flood control improvements.

The North Branch of the Susquehanna, specifically the Wyoming Valley segment, was investigated by the Federal Government and the analysis was presented in a report in 1880. Dredging of the river for navigation and the construction of dikes to concentrate flood flows into a single channel was accomplished near Wilkes-Barre in 1882. After repeated complaints that the dikes aggravated flood conditions in the area, in 1914 and 1917, the Corps of Engineers submitted a report (the latter published in House Document 320, 65th Congress, 1st Session) which outlined various measures of protection; however, further study was not authorized and funds were not appropriated for design or construction.

The North Branch was again studied for flood control in the 1920's and the report was published in House Document 647, 69th Congress, 2nd Session. Channel enlargement and the construction of levees were proposed. However, no Federal project was recommended due to the localized benefits attributable to any project.

House Document 370, 71st Congress, 2nd Session (April 1930) presented a review of the West Branch of the Susquehanna for flood control and water quality. It was determined that reservoirs were not economically feasible, levees would be a practical solution to the flood problem in urban areas, and pollution control was outside of the Corps' jurisdiction. No specific recommendations were made at that time due to an on-going basin wide study that was authorized by House Document 308, 69th Congress, 1st Session (see discussion on House Document 702, 77th Congress, 2nd Session).

A general report dated 15 December 1934 (authorized by House Document 308, above) studied five power projects, seven potential reservoir sites, and a plan for local flood protection at Binghamton, New York, but these projects were not considered economically justified.

On 15 February 1936, the Corps submitted a report titled "Survey of Streams in New York and Pennsylvania Affected by the Disastrous Flood of 6-7 July 1935," (report revised 23 April 1936 to include effects of the March 1936 flood) which studied the upper Susquehanna River Basin above the confluence of the Lackawanna River at West Pittston, Pennsylvania. Eighty potential reservoir sites were analyzed (33 in the upper Susquehanna River) of which 17 (15 in the upper Susquehanna River) were considered more favorable. Channel improvements which included dredging and/or constructing or raising existing levees at 7 locations (Hornell, Avoca, Corning and Painted Post, Binghamton, Lisle, Oxford, and Hammondsport), and modifications to existing bridges to accommodate 1935 flood flows were suggested. Local channel improvements at Hornell, Avoca, Painted Post, Lisle, and Oxford were authorized after submission of the 1936 report.

On 20 June 1936, the Corps of Engineers was authorized by Congress to conduct a preliminary flood control examination of the Allegheny and the Susquehanna Rivers for areas that previously had not been studied. Specific areas to be studied included Clearfield and Chest Creeks in the Susquehanna River Basin.

The Flood Control Act of 1936 authorized detention reservoirs and related flood protection works for Binghamton, Hornell, and Corning, and levees at 29 locations within the Susquehanna Basin (13 in southern New York and 16 in Pennsylvania). Southern New York flood control reservoirs authorized by the Flood Control Act of 1936 included Davenport Center, West Oneonta, East Sidney, Copes Corner, Whitney Point, Almond, and Arkport. The Corps was authorized to submit survey reports for the Susquehanna River and tributaries and specifically the Canisteo, Chemung, Chenango, Cohocton, Tioughnioga, Tioga, and Lackawanna Rivers.

The Susquehanna River at Sunbury was studied after the 1936 flood and the report appears in the House Document 366, 76th Congress, 1st Session (June 1939). The recommended plan

included levees and walls along the Susquehanna River and paralleling Shamokin Creek and several pumping stations. These improvements were to yield a level of protection four feet greater than the 1936 flood (flood of record).

In May 1939, the Corps sumitted a Definite Project Report for the Upper Susquehanna Basin to be considered as one portion of a basin-wide flood control plan. No reservoirs were recommended for the Chemung River basin; however, four reservoir sites were proposed for the Upper Susquehanna River to provide 100-year protection at Binghamton and 75 percent damage reduction in the upper basin. Disadvantages of upstream reservoirs include a lack of "natural sites" and relocation of several towns. Local flood protection works were designed to accommodate flows an average of 50 percent greater than the flood of record. Channel improvement would consist of dredging, channel straightening, levees and walls (raising of existing works were necessary), and the raising of railroad and highway embankments. Completed levee projects at Lisle and Painted Post were to be raised to accommodate the 100-year flood instead of the 1936 flood of record. It was found that channel protection above the confluence of the Unadilla River would be more expensive than upstream reservoirs. Proposed reservoirs projects included East Sidney, Davenport Center, Copes Corner, and West Oneonta. Channel improvement was suggested at Whitney Point, Addison, Almond and Lisle, and new levee projects were proposed at Binghamton, Elmira, Corning, Bath, and Canisteo. Request for authorization of all projects were deferred pending completion of the Survey Report which was in progress at that time.

A Survey Report of the entire Susquehanna River Basin, which was authorized by House Document 308, 69th Congress, 1st Session, was completed in May 1941 and appears in House Document 702, 77th Congress, 2nd Session (April 1942). The proposed flood control plan included authorization of reservoirs at Genegantslet and South Plymouth on the Chenango River, and Stillwater on the Lackawanna River; modification of existing local protection projects at Harrisburg and Sunbury to provide protection to the 1936 flood level and by local protection works at Tyrone on the Little Juniata River. All projects previously authorized by House Document 308 were recommended for abandonment. The projects that were deauthorized included Williamsport (levees); York (retarding dam and channel improvement); Milton (levees); Montgomery, Muncy, Jersey Shore, and Lock Haven (levees on the West Branch); and Bloomsburg, West Pittston, Swoyersville, Forty Fort, Kingston, Edwardsville, Plymouth, Nanticoke, Wilkes-Barre, and Hanover (levees on the North Branch).

The Flood Control Act of 1944 authorized the following Corps of Engineers' projects on the Susquehanna River: local protection works at Harrisburg and at Tyrone (Little Juniata River), and South Plymouth and Genegantslet Reservoirs. The Corps was also authorized to begin preliminary investigations for a reservoir at Raystown on the Raystown Branch of the Juniata River and local protection works at Endicott, Johnson City, and Vestal, New York.

In 1949, a report on the Susquehanna River in the vicinity of Endicott, Johnson City, and Vestal, New York, was completed. The report (House Document 500, 81st Congress, 2nd Session) stated that while existing flood control projects in the area had greatly reduced damages, the residual damage potential remained significant. The most feasible means of preventing these residual damages, in the area west of Binghamton, New York, would be construction of levees and appurtenant works to provide local protection of Endicott, West Endicott, Vestal, and Westover. The adoption of the project was recommended subject to requirements of local cooperation. The project was authorized in 1954.

Following a resolution of the Committee on Flood Control, House of Representatives, adopted 29 May 1946, the Board of Engineers for Rivers and Harbors reviewed House Document 702 to determine if any modifications contained therein were needed.

The report dated 31 December 1949, contained recommendations for a system consisting of four flood control reservoirs and one multiple-purpose reservoir on the West Branch about 4 miles above Keating.

A public hearing on that report was held by the Board of Engineers for Rivers and Harbors on 4 June 1951. At the hearing, interested parties presented additional information which required further consideration, particularly in regard to the Keating multiple-purpose reservoir. Information was received at that time regarding plans of a public utility company to construct a large steam-electric generating station on the West Branch Susquehanna River at Shawville, at an elevation which would be within the Keating reservoir area if the multiple-purpose project was built to the height proposed in the December 1949 report. Requests were subsequently received from public interests that the four flood control reservoirs be considered separately from the Keating multiple-purpose project in order that much needed flood control should not be delayed pending a further review of the Keating project. In view of these events, the Chief of Engineers authorized an interim report covering improvements for flood control and incidental benefits only, deferring consideration of plans for construction for multiple-purpose reservoirs involving hydroelectric power until a final report was prepared.

The interim report was completed in 1952. The report (House Document No. 29, 84th Congress, 1st Session, 2 Oct 1954) presented the results of a detailed investigation of the West Branch and its tributaries for flood control and allied purposes and pointed out the urgent need for flood control. The most feasible and economical means of providing the additional protection required was by the construction of four flood control reservoirs at the Curwensville, Kettle Creek, Blanchard, and First Fork sites. These resevoirs would be supplemented by local protection works under construction or planned by the Commonwealth of Pennsylvania. The Congress authorized projects for the First Fork, Kettle Creek, Curwensville, and Blanchard dams. By that time, the Commonwealth of Pennsylvania had decided to build the First Fork dam, and rename it the George B. Stevenson Dam.

A review report (House Document 394, 84th Congress, 2nd Session) on the North Branch Susquehanna River, completed in March 1954, stated that there was an urgent need for additional flood control along the North Branch of the Susquehanna River and principal tributaries to prevent recurrences of the $80 million in flood damages that had occurred from 1935 to 1946. The most feasible and economical means of providing additional protection required at that time was by the construction of flood control reservoirs at Cowanesque, and Tioga-Hammond sites; levees at Elkland, Nichols, and the Endicott-Westover-Vestal areas; and channel improvements on the Tioughnioga River at Cortland, on the Chenango River at Sherburne, on the Otselic River at Cincinnatus, and on the Susquehanna River in the vicinity of Conklin and Kirkwood. The projects were authorized in the River and Harbor Act of 1958.

A report on flood control in the Lackawanna River, Pennsylvania, was authorized pursuant to a resolution by the Committee on Public Works, United States Senate adopted 14 September 1955. The Board of Engineers was requested to review previous reports on seven rivers, including the Susquehanna River. They were to determine the need for modifications in the recommendations of the reports with regard to increasing flood protection. The most feasible and economical means of providing additional flood control protection along the Lackawanna River and its tributaries was by the construction of flood control reservoirs, levees, and channel improvements to supplement the Stillwater Flood Control Reservoir which had been completed. Accordingly, from the report (Senate Document 141, 87th Congress, 2nd Session), the construction of reservoirs on Fall Brook and Aylesworth Creek and levees and other improvements at Scranton were recommended. The projects were authorized in 1962.

House Document 565, 87th Congress, 2nd Session, "A Survey Report on Flood Control on the Juniata River, Pennsylvania", was completed in August 1961. The report stated that the most feasible plan of improvement on the Juniata River and tributaries was the construction of the Raystown Dam and reservoir for flood control, the generation of hydroelectric power, and other beneficial uses. The project was authorized in 1962.

In October 1962, Congress adopted a resolution directing a comprehensive study of the Susquehanna River Basin water and land resources. Prior to this, no basin-wide study of water resources management had ever been undertaken. The objectives of the "Susquehanna River Basin Study" were to evaluate the water resource potential of the basin, to determine the water resource requirements of the basin's population, to analyze alternative solutions, and to recommend programs necessary to manage this valuable resource to best serve the economic and social needs of the people.

The study was initiated in 1963 with the formation of the Susquehanna River Basin Coordinating Committee consisting of representatives of the U.S. Department of Agriculture; Army; Commerce; Health, Education, and Welfare; Housing and Urban Development; and Interior; the Federal Power Commission; the states of New York and Maryland and the Commonwealth of Pennsylvania. The job of the Coordinating Committee was to coordinate the many and varied facets of the Study and to make the decisions necessary to guide the sound conservation and development of the Basin's resources.

The Committee completed its study in 1970 and developed an "Early Action Plan" and a "Framework Plan" to meet the Basin's needs both immediate and long range. The needs considered included water quality, recreation, water supply, flood control, land management, electric power, streambank stabilization, and erosion control.

The Early Action Plan recommended structural projects and management measures to be implemented prior to 1980. The flood control recommendations fall into 5 catergories: 1) multiple purpose reservoirs; 2) small tributary reservoirs; 3) local flood protection projects; 4) upstream watershed projects; and 5) flood plain management.

The plan called for five multiple purpose reservoirs which included flood control storage. These projects are Charlotte Creek Development, South Plymouth Reservoir, Fabius Reservoir, Mud Creek Reservoir, and Fivemile Creek Reservoir and are shown on Figure 2. Further study of the Fabius, Mud Creek and Fivemile Creek reservoirs showed a lack of economic justification of these projects and study was terminated. Studies of the Charlotte Creek and South Plymouth projects were not pursued due to a lack of support.

Sixty-two small tributary reservoirs (each less than 25,000 acre-feet of storage) were recommended: twenty in New York, thirty-three in Pennsylvania, and four in Maryland. The primary purpose of their reservoirs was to be recreation, however, some would also provide flood protection for headwater areas. The locations of these reservoirs are shown on Figure 3.

Local flood protection projects at Marathon, New York; Westfield, Pennsylvania; Wyoming Valley Levee System, Pennsylvania; Philipsburg, Pennsylvania; Bloomsburg, Pennsylvania; Lock Haven, Pennsylvania; and Harrisburg, Pennsylvania were also recommended and are shown on Figure 4.

The studies of all of these potential local flood protection projects except for Lock Haven, Wyoming Valley and Harrisburg have been completed and have revealed that there were insufficient national economic benefits to justify them. Authorization of Advanced Engineering

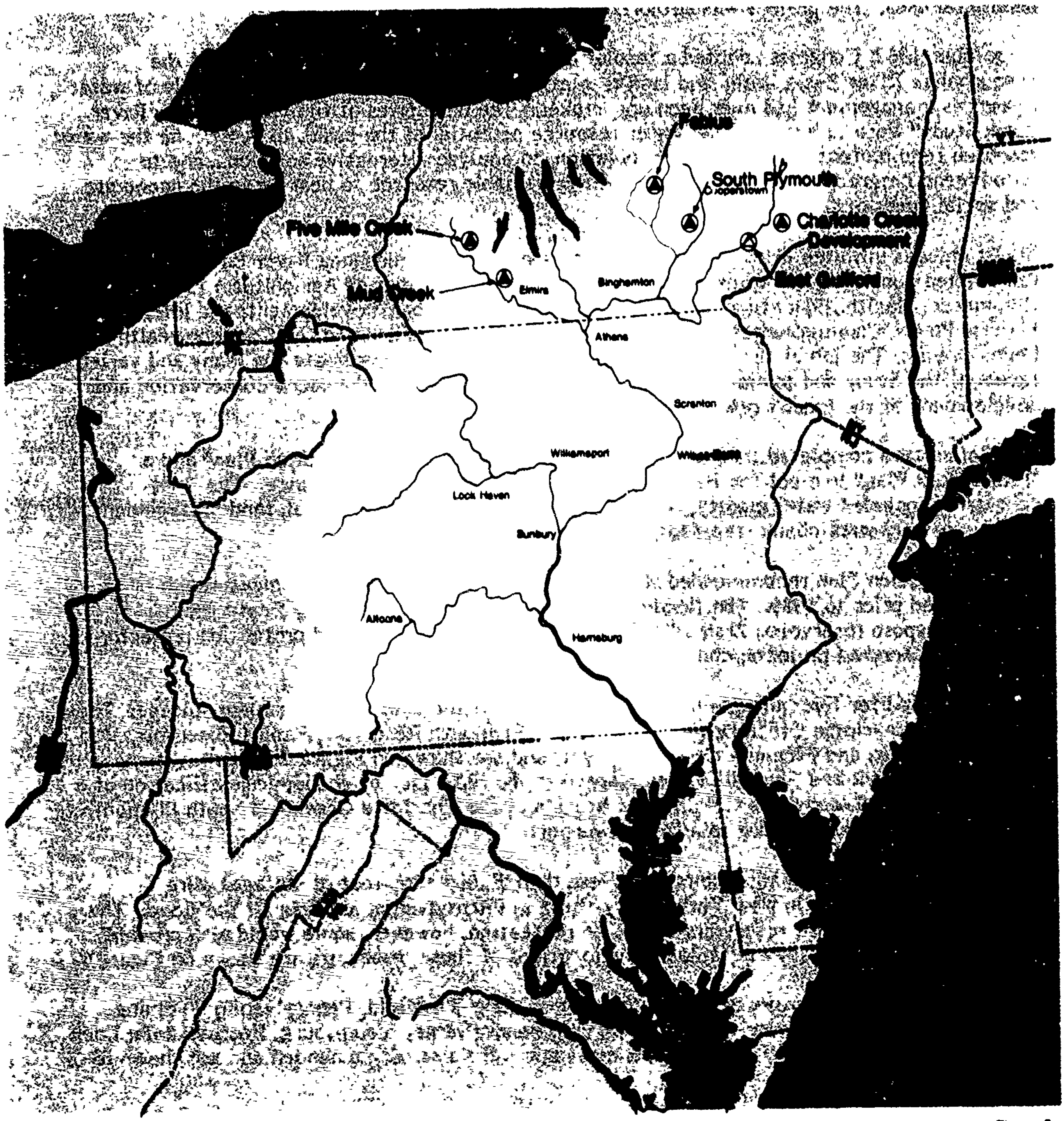
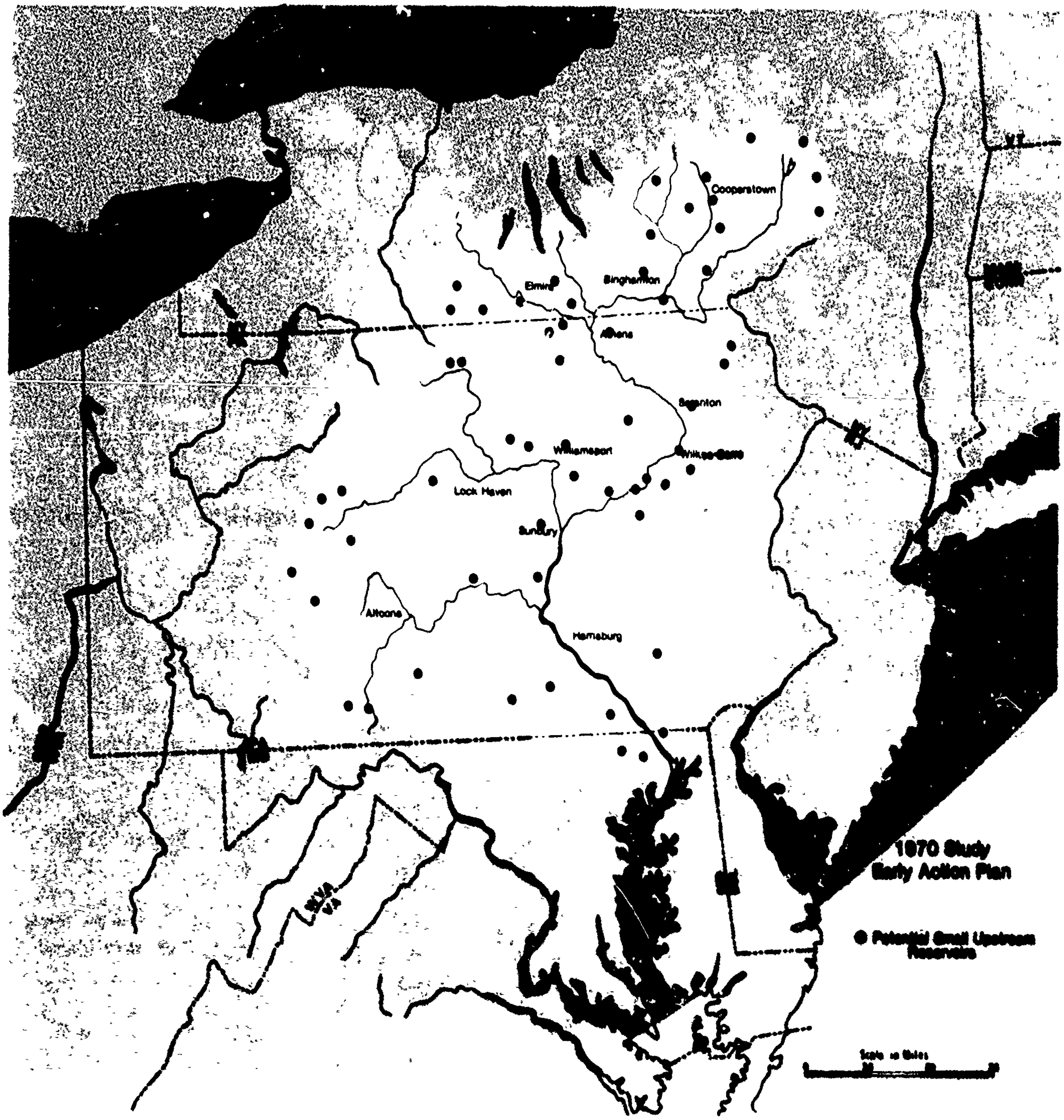

Fabius
South Plymouth
Cooperstown
Five Mile Creek
Mud Creek
Elmira
Binghamton
Athens
Scranton
Williamsport
Lock Haven
Sunbury
Altoona
Harrisburg

Figure 2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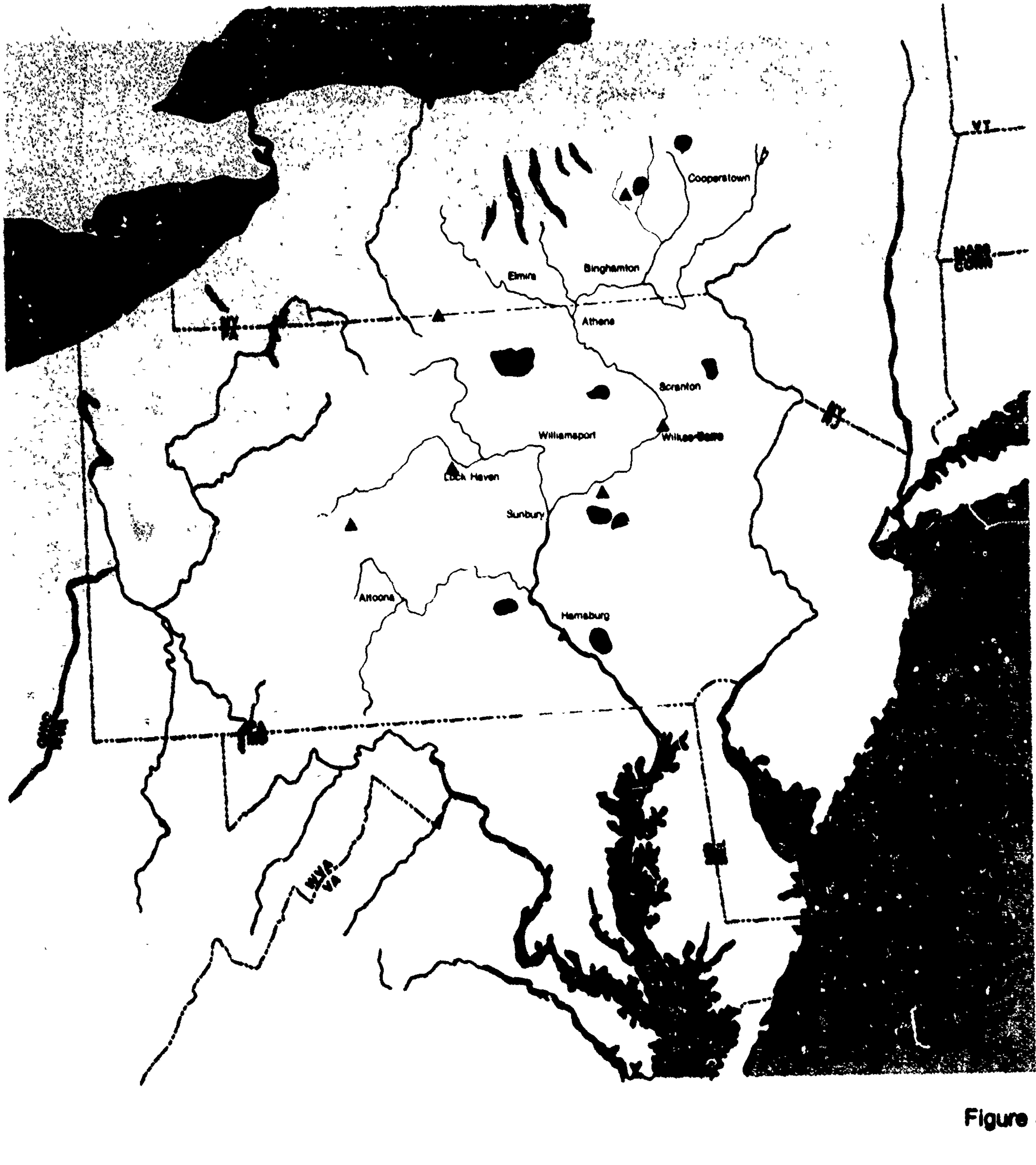
1970 Study
Early Action Plan

Figure 3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Sunbury
Altoona
Harrisburg

Figure 4

and Design studies of flood protection projects for Lock Haven, Pennsylvania (H.D. 94-577, 2nd Session), and increasing the level of protection provided by the existing levee and floodwall system in the Wyoming Valley, Pennsylvania (H.D. 94-482, 2nd Session), was provided by the 1976 Water Resources Development Act, PL 94-587 October 22, 1976. The survey scope study of flood protection for Harrisburg was completed in October 1977 and the report recommending authorization of a flood protection project for the Paxton Creek area and South Harrisburg is under review at the Washington level. Construction of the Philipsburg local flood protection project has been completed by the Commonwealth of Pennsylvania.

Nine upstream watershed projects were recommended which included nineteen impoundments (Figure 4). Study of all these projects by the Soil Conservation Service have been completed and fifteen impoundments were recommended and are under construction.

The Committee also recommended intensive floodplain management for seventeen areas shown on Figure 5. These areas were identified as having a high priority need within the time frame of the early action plan; thirteen because of highly concentrated potential damages that could not be protected by structural means and the remaining four in conjunction with recommended low channel dams and their associated recreational facilities.

The Coordinating Committee further recommended improvements of the existing flood warning network to minimize the risk of loss of life and damage to property for all identified reaches, regardless of the intensity of structural or other management measures provided. The recommendations for the flood control component of the Framework Plan included one multiple purpose reservoir (East Guilford, shown on Figure 2) and intensive floodplain management at twenty-six locations throughout the basin.

The North Atlantic Regional Water Resources Study (NAR) and the Appalachian Water Resource Study are complementary water resource studies which encompass all or parts of the Susquehanna River Basin.

The NAR study, authorized by Section 208 of P.L. 89-298, 27 Oct 1965, covers the entire populous Northeast from Maine to Virginia. The study was managed by the North Atlantic Division of the Corps of Engineers. It was a combined Federal-State effort with a Coordinating Committee similar to that of the 1970 Susquehanna River Basin Study. However, it was a less detailed study than the Susquehanna River Study in that its purpose is to provide a substantial contribution of fact and analysis to subsequent detailed plan formulation. The study addressed the problem of flood damage reduction in the Susquehanna River Basin. The existing system was found to be effective, as were those presently under construction or in design stage. In light of Regional Development objectives, a need was demonstrated for more structural devices. Flood plain management was viewed to have a better than average chance of success due to public attitudes and topography.

The NAR Study provides economic projections of economic development, translation of such projections of water availability both as to quantity and quality, and projections of related land resource availability, so as to outline the characteristics of projected water and related land resources problems and the general approaches that appear appropriate for their solution. This report was completed in 1972.

The Appalachian Water Resources Survey was carried out in response to Section 206 of the Appalachian Regional Development Act of 1965 (P.L. 89-4, 9 March 1965) which provided authorization to prepare a comprehensive plan for the utilization and development of water resources in the Appalachia Region to promote regional development. The report was prepared by the Office of Appalachian Studies, a specially formed group within the Corps of Engineers,

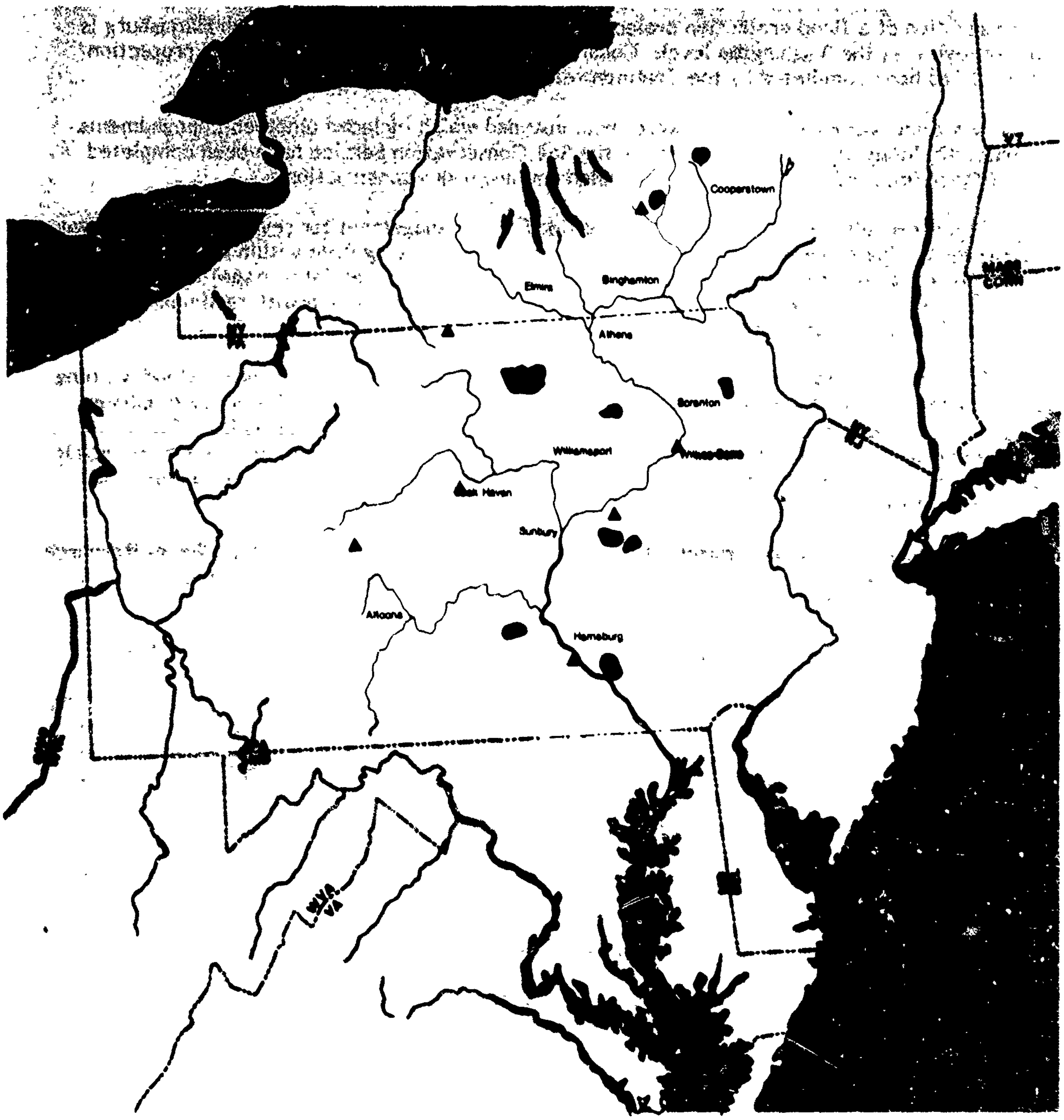

VT
Cooperstown
Elmira
Binghamton
Athens
Scranton
Williamsport
Sunbury
Altoona
Harrisburg
W.VA
VA

Figure 5

operating under the Ohio River Division Engineer. The study area was comprised of all or part of 13 states from Southern New York to mid-Alabama and Mississippi and included most of the Susquehanna River Basin. Specific areas of water resource development included flood control, water supply, water quality, power, and recreation, all with an eye on improving regional economic development. Recommendations for water development focused on hydro-power and recreation, with flood control as an incidental benefit.

The Susquehanna River Basin Commission, formed by a Federal-State Compact in 1970, adopted a Comprehensive Plan for Management and Development of the Water Resources of the Susquehanna River Basin in December 1973. This plan projected future demands, evaluated existing conditions, and made recommendations for an intergrated water plan for the Basin and included a specific Early Action Plan.

Concerning flood damage reduction, the Commission made six nonstructural recommendations: (1) maps should be prepared for all damage areas such that risks may be accurately assessed; (2) a general plan of existing and proposed flood plain uses, based on flood hazard, should be prepared as a guide for future management and development; (3) improve and expand basin-wide flood forecasting services; (4) educate the public in the area of flood warning and emergency procedures; (5) encourage participation in the Federal Flood Insurance Program; and (6) coordinate and encourage a basin-wide land management program.

Three structural recommendations were made: (1) a basin-wide plan should be developed to reduce flood damages; (2) to compare all measures and identify the best overall combination of feasible alternatives; and (3) the following authorized Federal projects should be funded and/or completed:

<u>Major Dams</u>

Tioga-Hammond Reservoir (Pennsylvania)
Cowanesque Reservoir (Pennsylvania)

<u>Watershed Flood Protection & Watershed Protection Projects</u>

Newton-Creek-Hoffman Creek (Schuyeer and Chemung Counties, New York)
Marsh Ditch (Alleghany and Steuben Counties, New York)
Briar Creek (Columbia County, Pennsylvania)
Nanticoke Creek (West Corners, New York)
Middle Creek (Synder County, Pennsylvania)
Nescopeck Creek (Luzerne County, Pennsylvania)

<u>Local Flood Protection</u>

Wyoming Valley (Pennsylvania)
Tyrone (Pennsylvania)

After the June 1972 flood, the Corps of Engineers prepared a post-flood report detailing the damages and hydrologic conditions which occurred. Volume I — Meterology and Hydrology, provides information of a general nature to facilitate an understanding of what happened during the storm and more detailed information to allow analyses to be made based on Tropical Storm Agnes. Volume II Damage and Recovery, describes and tabulates the total costs related to the damages caused by Agnes and describes the recovery organization and effort. Several flood control studies have also been carried out by the Corps of Engineers under the continuing authority of Section 205 of the Flood Control Act of 1948. Table 1 lists those communities studied, and the status of each study.

Many of the upstream watersheds have been studied by the Soil Conservation Service of the Department of Agriculture. Dean Creek in Tioga County, New York, Great Brook in Chenango County, New York, and Corey Creek in Tioga County, Pennsylvania were authorized as pilot projects under PL 74-46. These projects provide watershed protection and flood protection. The Watershed Protection and Flood Protection Act, PL 83-566, authorizes the Secretary of Agriculture through the Soil Conservation Service and the Forest Service to provide technical and financial assistance to local organizations in planning and carrying out watershed projects. The watershed projects are for flood prevention, recreation, fish and wildlife development, municipal and industrial water supply, and agricultural water management, which includes irrigation and drainage.

Under provisions of PL 83-566 some 35 upstream watersheds have been studied for possible installation of flood water retarding structures, dikes, channels, and acceleration of the land treatment practices. As of January 1, 1978, fifteen of these watersheds have been planned and authorized for implementation of the projects. Construction is in progress on six of these projects and has been completed on nine others. Watershed work plans are currently being prepared on four additional watershed projects.

The Pennsylvania Department of Environmental Resources has made investigations and prepared reports for numerous local communities throughout the basin and has completed twenty-six flood protection projects as a result of such studies. In addition, the Department has completed numerous stream channel clearance projects at other localities where accumulated debris and sediment have caused flooding.

The New York Department of Environmental Conservation has also conducted studies and prepared reports which address the flood control problems in the New York portion of the basin. Two such reports are the "Comprehensive Water Resources Plan for the Chemung River Basin" dated May 1975 and the Comprehensive Water Resources Plan for the Eastern Susquehanna River Basin" dated September 1975.

Problem Identification

Problem identification in this study is directed by the study authority to address those water and related land resources which are primarily associated with flooding conditions. This section deals with the broad, basin-wide conditions as well as those more sharply defined concerns in specified communities.

EXISTING CONDITIONS

Environmental Setting and Natural Resources

The Susquehanna River Basin lies almost entirely within the Appalachian Highlands Province with only a narrow part at the southern tip lying within the Atlantic Coastal Plain Province. The basin's 27,500 square mile area extends from the source of the Susquehanna River in Otsego County, New York to the mouth of the Susquehanna River in Havre de Grace, Maryland at the Chesapeake Bay. The basin is about 170 miles east to west and 250 miles from north to south. The location and major tributaries were shown in Figure 1.

TABLE 1

LOCATIONS STUDIED UNDER SMALL FLOOD CONTROL

PROJECTS PROGRAM

Athens, Pa.	Negative Report Complete
Brookside, Wilkes Barre, Pa.	Favorable reconnaissance report completed. Project implemented by locals.
Highspire, Pa.	Negative Report Complete
Middletown, Pa.	Negative Report Complete
Milton, Pa.	Negative Report Complete
Spring Creek, Swatara Township, Pa.	Negative Report Complete
Loyalsock Township, Pa	The project was approved on 2 December 1976. Now under construction.
Painted Post, NY	Positive report complete. Project constructed by State of New York.
Pine Grove, Pa.	Positive reconnaissance report complete. Detailed Project Report now being prepared.

The Susquehanna River makes four major changes in direction as it flows south to the Chesapeake Bay. From its source, the Susquehanna River flows in a southwesterly direction for about 150 miles to the confluence with the Chemung River. It then flows in a southeasterly direction for 60 miles to the confluence with the Lackawanna River. The Susquehanna River then flows in a southwesterly direction for approximately 100 miles to the confluence with the Juniata River. The flow in the final 75 miles to the Chesapeake Bay is again in a southeasterly direction.

The principle streams and tributaries of the Susquehanna River Basin and their drainage areas are listed in Table 2. The Cohocton and Chemung Rivers drain the northwestern portion of the basin and flow southeasterly for a distance of about 80 miles to the confluence of the Chemung River with the Susquehanna River. The West Branch of the Susquehanna River flows in an easterly direction for 150 miles to join the Susquehanna River and drains the west-central areas of the Susquehanna Basin. The Juniata River flows for 90 miles in an easterly direction to its confluence with the Susquehanna River and drains the southwestern section of the basin.

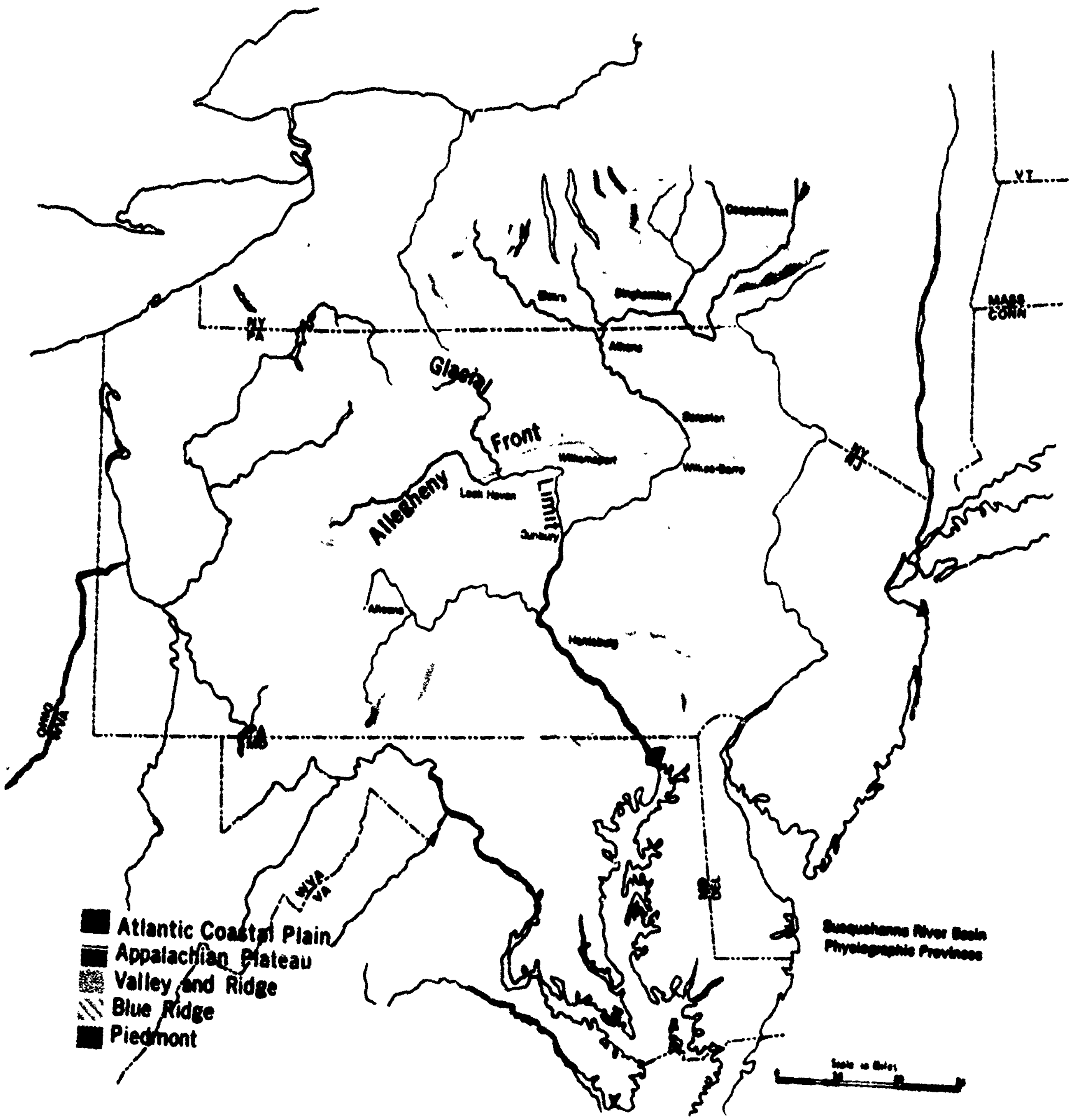
The Appalachian Highlands are divided within the Susquehanna Basin from north to south into four distinct Physiographic Provinces (Figure 6): The Appalachian Plateau, Valley and Ridge, Blue Ridge, and Piedmont Provinces. Approximately 56 percent of the Susquehanna River drainage area is in the Appalachian Plateau Province. A large portion of the Susquehanna drainage basin within the Appalachian Plateau has been glaciated, producing U-shaped valleys and gentle relief in contrast to the unglaciated portion of the basin, which is rugged and contains V-shaped valleys. After leaving the Plateau, the Susquehanna River enters the Valley and Ridge Province, which is a region of alternating hard and soft sedimentary rocks that have been bent by compression into long ridges and valleys. The region may be divided into a mountainous section to the north and a Great Valley Section to the south. The northwestern boundary of this province is formed by an erosional escarpment, the Allegheny Front. Approximately 36 percent of the Susquehanna River drainage basin is in the Valley and Ridge Province. The northeastern part of the Valley and Ridge Province has been glaciated and is the area where the anthracite coal fields exist. South of this province, the river flows through the Piedmont Province. The Piedmont consists mainly of rocks that have been highly altered and disturbed, but also includes younger, less disturbed and altered Triassic rocks. It has a gently undulating relief sloping southeastward and occupies about 7 percent of the area of the basin. The Blue Ridge Province which forms less than one percent of the drainage basin, abuts against the northwestern side of Piedmont Province. The Blue Ridge Province includes a number of ridges and mountain ranges extending from southern Pennsylvania to northern Georgia. Some of these ridges may reach an elevation of 2000 feet. The southern end of the basin (less than one percent) is in the Atlantic Coastal Plain region. The "Fall Line" separates the southeastern boundary of the Piedmont from the Atlantic Coastal Plain. This area has a subdued topography and very few tributaries to the main drainage.

Soils of the Susquehanna River Basin are many and varied. Those of the northern portion of the watershed are formed from materials laid down by glacial action. The glacial drift covered the uplands with till, or unsorted glacial material, and filled the valleys to great thicknesses with stratified sand, gravel and ancient lake deposits of silt and clay. The central portion of the drainage basin is a region of northeast - southwest oriented parallel, steep-sided, sandstone ridges separated by shale and limestone valleys. The soils in both the central and southern parts of the basin are formed by disintegration of underlying rock. They range in depth from shallow to deep, and are generally well drained. The Piedmont soil typical of the southern portion of the basin are derived principally from red Triassic shale in the northern section and schist, gneiss and quartzite in the southern section of the province.

TABLE 2

PRINCIPAL STREAMS IN THE SUSQUEHANNA RIVER BASIN

	Drainage Area Square Miles
Susquehanna River	27,000
Unadilla River	518
Chenango River	1,530
Tioughnioga River	735
Chemung River	2,595
Tioga	761
Cowanesque River	300
Lackawanna River	348
Nescopeck River	174
Catawissa Creek	153
West Branch Susquehanna River	6,981
Pine Creek	986
Bald Eagle Creek	770
Sinnemahoning Creek	1,035
Driftwood Branch	319
Bennett Branch	367
Moshannon Creek	274
Clearfield Creek	393
Wisconisco Creek	116
Juniata River	3,404
Raystown Branch	963
Frankstown Branch	650
Little Juniata River	343
Conodoguinet Creek	506
Yellow Breeches Creek	219
Swatata Creek	517
Conewago Creek	52
Octoraro Creek	176



Glacial
Front
Allegheny
Limit
Sunbury
NY
PA
VT
MASS
CONN
Atlantic Coastal Plain
Appalachian Plateau
Valley and Ridge
Blue Ridge
Piedmont

Figure 6

The water resources of the Susquehanna River Basin service a variety of purposes. Currently, 25 to 30 percent of the population of the basin is estimated to use underground water sources; the remaining 70 percent use surface water sources. The basin contains a variety of scenic recreational and boating areas. There are 4,700 miles of trout fishing streams, more than 1,400 miles of warm water fishing streams, and more than 53,000 surface areas of lakes, reservoirs, and artifical ponds that provide fishing and boating activities. The Susquehanna River Basin has 19 streams proposed for either wild or scenic classification. More than 400 miles of streams and rivers in the basin have been classified as degraded as a result of organic wastes. In coal mining areas of northcentral and northeastern Pennsylvania, more than 1,300 miles of streams have been degraded by mine drainage. Other sources of pollution occur as a result of agricultural runoff, pesticides and heated discharges from power plants.

Land Use

Approximately 55 percent of the land in the Susquehanna River Basin is forest land that is either private or state-owned. Most of this forest land is in the north and north-central portions of the basin where the land is rugged and mountainous. Rural land uses occupy approximately 24 percent of the land area in the Susquehanna River Basin and are concentrated primarily in the valleys of the Ridge and Valley Province and in the Piedmont area. Much of this land is used as cropland and pastureland. The urban category accounts for less than five percent of the total land area and is concentrated primarily along the rivers. The remaining 16 percent includes land outside urban areas of more than 2,500 population and agricultural land not used for crops, pasture or forest, idle farm land, and recreation areas, parks, highways, water areas and domestic uses.

Land use in the Susquehanna River Basin has not changed rapidly or radically in recent times. Population trends of the region indicate slow growth. There has been a slight shift from agricultural land uses to urban and forest utilization, with urban uses expected to occupy 10 percent of the land by 1985. The major railroad centers of Harrisburg and Altoona plus the increased numbers of limited access highways since 1955 have aided in increasing industrialization of the basin. Farmlands are primarily used for crops rather than pastures because it is more economical, a practice that is expected to continue in the future.

The agricultural products of the Susquehanna River Basin are a function of the soil capabilities and the competitive position of the basin with respect to other regions of the country. Farmers in the basin primarily serve local markets and the majority of nearby cities of Pittsburgh, New York, Philadelphia, and Baltimore. Milk and dairy products account for almost 50 percent of the products. Poultry products are second in value. Within the basin, Lancaster Country, Pennsylvania, is the leading producer of field and forage crops, livestock products, diary products and poultry products. Adams County, Pennsylvania, is the major fruit producer and York County, Pennsylvania, is the largest producer of vegetables and potatoes.

Forests support an important wood products industry. Over 90 percent of the timber is hardwood with oak, oak-hickory, beech, birch and maple trees being the major sources. Both lumber production and pulpwood production are expected to increase in the future.

The Susquehanna River Basin has a variety of mineral resources. Coal is by far the most important mineral resource mined in the area. Bituminous coal fields are found primarily in Blair, Cambria, Clearfield, Centre, Clinton, Cameron, Elk, Lycoming and Tioga counties in Pennsylvania. Anthracite coal deposits occur in Lackawanna, Luzerne, Northumberland, Schuylkill, Lebanon and Dauphin counties of Pennsylvania. The basin also contains reserves of iron, clay, and shale, ganister rock , pyrite, salt, sand and gravel, and stone. Small to moderate reserves of peat, flint, feldspar and mica exist in the region. Reserves of natural gas are

declining. Petroleum, cobalt, copper and precious metals exist in small amounts but will not support production beyond exhaustion of the currently worked reserves. Resources of aluminum, molybdenum, titanium, uranium, garnet, barite, fluorspar, graphite and talc are insignificant.

Climate

The Susquehanna River Basin has a continental type of climate. The average annual temperature ranges from about 44 F in the northern part of the basin to about 53 F in the southern part. Average January temperatures range from 22 F at Montrose, Pennsylvania to 33 F at York, Pennsylvania. Average July temperatures range from 66 F at Phillipsburg, Pennsylvania, to 78 F at Holtwood, Pennsylvania. Extreme temperatures of 107 F and -39 F have been recorded. The average annual growing season ranges from 150 days in the northern areas to approximately 200 days near Harrisburg, Pennsylvania.

Average annual rainfall is about 39 inches over the entire basin and ranges from 32 inches at Wellsboro, Pennsylvania to 45 inches at Cresson, Pennsylvania. In the extreme years, over 50 inches of rain have been recorded, but drought years have seldom recorded less than 25 inches. Variation in the average annual snowfall is also found within the basin, ranging from 28 inches at Holtwood, Pennsylvania to 85 inches at Binghamton, New York. Local variations in topography often result in varied precipitation patterns. Floods occur each year in the basin usually in early spring. Floods most frequently occur as a result of heavy rainfall on top of heavy snow accumulation or as a result of heavy rainfall on previously saturated soil, not precluding, however; the unusual events such as tropical storms and/or hurricanes. The historic flows for major tributaries to the Susquehanna River are given in Table 3.

Flood History: Despite the existing flood control system, flood damages occur annually in scattered reaches of the Susquehanna River Basin. While major floods can and have taken place in all seasons of the year, the most frequent flooding on the major rivers of the basin happens in late winter and early spring.

Flooding within the basin normally results from storms of three types. Cyclonic storms, caused by the converging inflow of warm moist air from the Atlantic Ocean just ahead of slow-moving cold fronts, produced major flooding in 1889 and 1936. Rainfall from storms of this type, when augmented by snowmelt, and saturated soil conditions can produce major floods throughout the entire Basin. Tropical storms and hurricanes which move into the Basin from the south and southeast produced severe flooding in several areas in 1884, 1933, 1955, 1972 and 1975. These storms usually do not cover large areas of the basin and rarely reach the upper or Allegheny Plateau portion of the basin because of the distance from the coast and the rugged intervening Ridge and Valley Province. Heavy thunderstorms, particularly in the small watersheds, have also caused severe flooding in limited areas throughout the basin. Storms of this type usually occur in summer and fall and produce floods of short duration. In addition to flooding caused by the aforementioned storms, some areas in the basin are flooded as a result of ice jams.

Runoff of flood proportions depends on many factors which include storm intensity, distribution and duration, extent of rainfall, antecedent soil moisture, depth and duration, extent of snow cover, and vegetative cover. Historically, the predominance of spring floods on the Susquehanna River reflects the effect of the longer and more widespread spring rainfall augmented by snowmelt. Tributary streams have a history of severe flooding caused by intense local summer storms, however, it is a rare event when they cause flooding on the main river system.

TABLE 3

HISTORIC FLOW PATTERNS FOR MAJOR RIVERS

IN THE SUSQUEHANNA RIVER BASIN

Location	River	Average (cfs)	Minimum (cfs)		Maximum (cfs)
Conklin, NY	Susq.	3558	85	(1964)	61,600(1936)
Waverly, NY	Susq.	7400	237	(1964)	128,000(1935)
Chemung, NY	Chemung	2494	49	(1964)	189,000(1972)
Towanda, PA	Susq.	10454	334	(1964)	345,000(1972)
Wilkes-Barre, PA	Susq.	13174	508	(1964)	345,000(1972)
Danville, PA	Susq.	15154	508	(1964)	363,000(1972)
Renovo, PA	W. Br. Susq.	4912	80	(1908)	236,000(1936)
Lewisburg, PA	W. Br. Susq.	10510	---	-----	300,000(1972)
Sunbury, PA	Susq.	25830	964	(1971)	620,000(1972)
Mapleton Depot, PA	Juniata	2416	68	(1964)	125,000(1972)
Newport, PA	Juniata	4253	207	(1964)	190,000(1936)
Harrisburg, PA	Susq.	34110	1700	(1964)	1,020,000(1972)

While historic records mention numerous floods as early as 1740, the first recorded floods were in 1810 and in 1865 in the lower and upper portions of the basin, respectively. One of the earliest recorded floods of major significance occurred in June 1889 when three days of heavy rainfall centered over the western portion of the basin. This storm, coupled with the denuding of the land by lumbering operations, produced the largest flood on record on the main stem of the Juniata River and the second or third largest of record on some reaches of the West Branch, the Tioga River, and the Chemung River.

In July 1935, a succession of heavy thunderstorms covered the upper basin producing unprecedented flood discharges on streams in New York, concentrating on the Tioughnioga, Chenango, and Chemung Rivers and many smaller tributary streams. Record high flood stages were recorded on many of these upstream areas. This series of storms was so localized, however, that stages below Binghamton, New York did not reach record proportions and below Wilkes-Barre, Pennsylvania, the flood was only of minor importance.

The greatest recorded flood having a basin-wide effect, prior to the Tropical Storm Agnes flood, occurred in March 1936 with two floods occurring in successive weeks. Runoff from precipitation augmented by snowmelt resulted in flood stages on all major streams. The March 1936 flood was the largest flood of record along much of the Main Stem and the West Branch Susquehanna River, the Little Juniata, Frankstown, and Raystown Branches of the Juniata River, and a few smaller tributaries throughout the basin. Flows of record were established by the runoff from this event, which in some portions of the basin were not exceeded by Agnes.

The May 1946 flood, which was caused by intense rainfall on the previously saturated watershed, was the largest of record, at that time, on the Tioga and Chemung Rivers and on the short reach of the Susquehanna River from the Chemung River to Towanda, Pennsylvania. Record flood discharges were also produced on many of the northern tributaries of the West Branch.

Tropical Storm Agnes in June 1972 was the most costly natural disaster in the history of the Basin. This flooding was a result of many factors which combined to produce record flood stages at a great number of locations within the basin. Moderate to heavy showers during the week preceeding the flooding increased soil moisture content levels far above normal. Early in the week of the flooding, an extra-tropical low pressure system moved slowly eastward through the southwestern New York region accompanied by heavy showers and thundershowers. Tropical Storm Agnes, which had originated days earlier as a tropical depression of the Yucatan Peninsula in the Gulf of Mexico, had traveled north then northeastward to a location just east of the New Jersey coast and began a westward movement into southern New York. Then after a slow loop in central and western New York, a weakening Agnes moved through New York State and was absorbed by the storm center over Pennsylvania. This combination of events resulted in the dumping of 8-16 inches of precipitation at most locations in the Basin.

The unusual combination of meteorological circumstances which produced and modified the system were previously unparalled. Most severe effects were confined to the Middle Atlantic area and the Susquehanna River Basin in particular. Heavy precipitation and resultant damage affected the Ohio, Potomac, Delaware, and James River drainages to a serious but lesser extent.

In September 1975 heavy rains from Tropical Storm Eloise, which traveled over the basin, combined with the effects of soils previously saturated by precipitation from a frontal system to produce record flood heights at some locations in the basin. The Chemung Basin and the lower portion of the West Branch of the Susquehanna were the hardest hit by this storm.

Severe flooding of a more local nature has affected portions of the basin at times other than those previously mentioned. The majority of these have been the result of extended showers and thundershowers. Table 4 shows the date of the flood of record and the probability associated with its reoccurrence within any given year, for various gage locations throughout the basin.

Archeological and Historical Resources

There are 160 historic sites within the Susquehanna River Basin that are recognized by the U.S. Department of the Interior in the National Register of Historic Places as published in the Federal Register, December 31, 1976. Nine of the sites are in Maryland, 34 sites are in New York, and 117 sites are in Pennsylvania. Thirty-two historic sites are in Lancaster (18 sites) and Dauphin (14 sites) counties in Pennsylvania. Nine of these sites are located in Lancaster City, Lancaster County. Harrisburg in Dauphin County is the site of ten historic places. Other areas of concentrated historic sites are Scranton, Bellefonte, York, Lebanon, Altoona, and Wilkes-Barre, all in Pennsylvania, and Binghamton, New York.

The Susquehanna River provided early Indians of the basin with good hunting grounds and water ways for transportation. The Mohawk town of Ohwaga, north of Binghamton, New York, may be the oldest Indian settlement on the river. Tioga Point, Wyoming, and Shamokin were other settlements of importance. Archeological findings of Indian settlements dating from the early 17th century exist along the Susquehanna River South of Harrisburg and are believed to belong to a group of Indians known as the Susquehannocks. However, by 1789 all their lands were ceded to the state except for a small portion on the Allegheny River, which is outside the Susquehanna River Basin. Lancaster County, Pennsylvania, is the site of a number of good archeological diggings containing Indian relics and objects.

Biological Resources

Regions within the Susquehanna River Basin vary greatly in topography, soils, drainage, geology and land use. Because of this diversity, the area exhibits a wide variety of vegetation and wildlife. In the northern portion of the basin (New York and northern Pennsylvania) the dominant forest type is maple-beech-birch. The southern portion of the Susquehanna River Basin has a dominant forest type of oak-hickory with occasional pine forests intermixed. Other major trees in the basin include white pine, pitch and Virginia pines, various oaks, elms, ash, red-maple, and aspen. Also found in the basin are numerous wild flowers and berries. Mountain laurel and rhododendron are common shrubs on the mountain slopes.

The many streams, reservoirs, ponds, bogs and marshes in the Susquehanna River Basin provide diverse environmer both floating and attached forms of aquatic plants. Microscopic, floating phytoplankton are typically abundant in quiet waters although their abundance may be increased significantly by slight to moderate amounts of organic pollution. The basin also provides an environment for higher aquatic plants such as the pond weeds, floating plants such as water lilies and emergents such as cattails.

The many lakes, ponds, marshes and streams of the Susquehanna River Basin support approximately 45 species of fish with brook, brown and rainbow trouts being the most common cold water fishes of the basin. In order to provide sufficient fishing for recreation, large numbers of streams that support natural trout populations or provide marginal habitat for trout are stocked. Common warmwater fishes of the basin are smallmouth bass, muskellunge (introduced), pike, walleye, catfish, perch, sucker, black crappie, and blue gill. Stocking of warmwater fishes occurs, but only to a limited extent.

TABLE 4

FLOODS OF RECORD AT SELECTED SITES

Gage Location/Drainage Area (Sq Mi)	Date of Flood of Record	Flow cfs	Flow cfs/sq.mi.	Expected Return Frequency 1/ Natural	Expected Return Frequency 1/ Existing
Susquehanna River					
Unadilla, NY 982	1936	31,300	31.9	110	238
Conklin, NY 2232	1936	61,600	27.6	45	63
Vestal, NY 3960	1936	107,000	27.0	29	77
Waverly, NY 4773	1972	121,000	25.4	17	26
Towanda, PA 7797	1972	320,000	41.0	430	1200
Wilkes-Barre, PA 9960	1972	345,000	34.6	200	500
Danville, PA 11,220	1972	363,000	32.4	220	400
Sunbury, PA 18,300	1972	620,000	33.9	76	147
Harrisburg, PA 24,100	1972	1,020,000	42.3	227	357
Marietta, PA 25,490	1972	1,080,000	41.6	250	330
Unadilla River					
Rockdale, NY 520	1936	17,500	33.7	36	36
Chenango River					
Chenango Forks, NY 1483	1935	96,000	64.7	217	400
Tioughnioga River					
Cortland, NY 292	1935	13,000	44.5	45	45
Chemung River					
Corning, NY 2006	1972	228,000	113.7	769	3300
Chemung, NY 2506	1972	189,000	75.4	285	2000
Tioga River					
Tioga, PA 282	1972	59,000	209.2	122	10,000
Lindley, NY 771	1972	128,000	166.0	182	10,000
Erwins, NY 1377	1972	190,000	138.0	313	3300
Cowanesque River					
Lawrenceville, PA 298	1975	43,700	146.6	50	50
Canisteo River					
West Cameron 342	1972	43,000	125.7	330	900

TABLE 4 (Con't.)

FLOOD OF RECORD AT SELECTED SITES

Gage Location/Drainage Area (Sq Mi)	Date of Flood of Record	Flow cfs	Flow cfs/sq.mi	Expected Return Frequency 1/ Natural	Expected Return Frequency 1/ Existing
Cohoctor River					
Campbell, NY 470	1935	41,000	87.4	175	175
Lackawanna River					
Archbald, PA 180	1942	9,510	88.1	118	330
Old Forge, PA 332	1955	31,000	93.4	128	156
West Branch Susquehanna River					
Curwensville, PA 367	1936	13,300	36.2	50	220
Karthas, PA 1462	1936	135,000	92.3	220	500
Renovo, PA 2975	1936	236,000	79.3	100	285
Williamsport, PA 5682	1972	279,000	49.1	63	192
Lewisburg, PA 6847	1972	300,000	43.8	56	125
Juniata River					
Huntingdon, PA 816	1936	68,000	83.8	116	116
Mapleton Depot, PA 816	1936	165,000	81.3	130	550
Frankstown Branch, Juniata River					
Williamsburg, PA 291	1936	47,600	163.6	1250	1250
Raystown Branch, Juniata River					
Saxton, PA 756	1936	80,500	106.5	420	420

1/ Existing frequency reflects the effects of existing resevoirs.

About 60 species of mammals are known to inhabit the Susquehanna River Basin. The most well known are the protected game animals, which include the black bear, white-tailed deer, cottontail rabbit, hare, squirrel, raccoon, woodchuck and bobcat. Common protected fur bearers include the mink, muskrat, otter, skunk, beaver and oppossum.

The Susquehanna River Basin contains a diversity of game species. The principal forest game species important in meeting recreational needs are white-tailed deer, black bear, ruffed grouse, gray squirrel, rabbits, raccoons and wild turkeys. Farm small game species include pheasants, cottontail rabbits and bobwhite quail. Other game birds are the mourning dove, geese, and various other waterfowl.

More than 170 species of birds are commonly observed in the basin. The Susquehanna River Basin is generally included in their normal range either as a site of residence or as a migratory route. Wood warblers are the most common birds of the basin, with more than 30 species frequently observed. Grosbeaks, finches, sparrows and buntings are also common. During the spring and fall, over 20 species of waterfowl can be seen.

Five endangered species are know to occur in the Susuquehanna River Basin. An endangered species is one whose prospects of survival and reproduction are in immediate jeopardy. The bog turtle restricted to fresh water marshes and bogs from Connecticut to North Carolina is identified as an endangered species in Pennsylvania by the Pennsylvania Fish Commission. The Maryland darter is found only in Swan Creek near Havre de Grace, Maryland. Two bird species, the American peregrin falcon and the southern bald eagle are endangered species that can occasionally be found within the basin. The Indiana bat is the only endangered mammal that can occasionally be found in the basin.

Social-Economic History

The early history of the Susquehanna River Basin was influenced by the Susquehanna River as a source of transportation and by agriculture as a source of income and occupation. The river served as a source of transportation for trade and commerce and also as a source of power for mills. Consequently, many of the area's earliest communities developed on land adjacent to the Susquehanna River. However, the river proved to be an unreliable source of transportation because of wide fluctuations in flows, swift currents and heavy ice flows during the winter. To meet these problems and to improve transportation, an ambitious canal building program was begun to connect the basin with markets in Philadelphia. During the 1830's an extensive system of canals was built, which paralleled much of the Susquehanna River. Canals were built along the Susquehanna River's main stem, north branch and west branch as far as Lock Haven. A canal system also paralleled the Juniata River. The Union Canal paralleled the Swatara Creek and went on through Lebanon to connect the basin's canal network with the Schuylkill River. In addition, a network of canals was constructed in New York State to tie together the Erie and Susquehanna Canal networks.

The early economy of the Basin was based upon the export of lumber and agricultural products. The heavily forested areas in the Basin's northern tier became the source of a major lumber industry. Timber from the large forested areas was cut and then floated down the West Branch of the Susquehanna River to saw mill communities along the river. During the period from 1850 to 1870 this portion of the Basin was a national leader in lumber production. Williamsport became the lumber capital of the United States. However, this prosperity was brief because over-cutting quickly depleted the forests and left the area without their natural resource. By the end of the 19th century, lumber was no longer a major factor in the Basin's economy. The economy of the southern portion of the Basin at this time was based upon agriculture. The fertile soils and rolling topography made this area a center of agricultural activities. The Basin

maintained its position of agricultural importance until around 1850 when the rich farming areas of the Middle West were cultivated and had become accessible by rail and canal with the markets of the East Coast.

The industrial revolution of the 19th century had a significant impact upon the basin. Manufacturing and coal mining in the basin began to replace lumbering and agriculture as the centers of economic activity. Manufacturing became an important activity especially in those communities adjacent to the Susquehanna River. The river provided a source of water for cooling, processing and waste disposal. The areas adjacent to the river also provided both large expanses of land for factory development and expansion and easy access to railroad lines for transportation. The iron industry was one of the earliest industrial activities in the basin. Relying upon local reserves of iron ore, limestone, and charcoal, iron furnaces were built throughout the central portion of the basin in the first half of the 19th century. By 1850, nearly 7,000 men were employed by the iron industry in the Juniata Valley alone. Limited amounts of iron ore and charcoal resources prevented further development. However, some technological advances did prolong the basin's iron industry. Several large steel mills were constructed at Steelton, Harrisburg and Scranton. Over a period of time much of the steel industry began to migrate to the Great Lakes area because of their proximity to the iron ore resources. In addition to the iron and steel industry, there were other major manufacturing activities started within the basin at this time. Specific major industrial activities included the Ingersoll-Rand Company at Painted Post, New York; Corning Glass at Corning, New York; and shoe manufacturing at Endicott-Johnson, New York. Other major industrial activities in Pennsylvania included the Hershey Chocolate Company in Hershey, locomotive shops in Altoona, Piper Aircraft in Lock Haven and Hamilton watches in Lancaster. Coal mining also became a major factor in the basin's economy. The coal mining industry experienced significant growth as the demand for coal as a source of fuel increased. Both bituminous (soft coal) and anthracite (hard coal) are found within the basin as noted in the section on land use. Coal mining activities in both the anthracite and bituminous regions began to experience serious reductions in both production and employment following World War I. This decline has continued except for a brief period during World War II. Reasons for the decline of coal as a fuel was the introduction and acceptance of cheaper and more convenient fuels such as oil and gas. In addition to the serious economic problems caused by the decline of the coal industry, it also left behind serious environmental problems in the form of acid mine drainage and scarred topography. However, coal may experience a significant resurgence as a source of energy in view of decreasing sources of oil and natural gas.

Contemporary Social-Economic Setting

Because of the size of the Susquehanna River Basin, it is difficult to characterize the entire socio-economic posture of the basin. The basin has shown a wide disparity in its socio-economic characteristics. Some areas have had remarkable economic prosperity while others have suffered through periods of economic difficulty. Overall, the basin has shown recent population and economic growth. Total basin population had grown from 3,250,000 in 1950 to 3,418,000 in 1960 to 3,621,[illegible]33 in 1970. Most of the population growth has occurred; however, in the lower and New York portions of the basin. Portions of the basin have experienced serious erosion of its population and economic base. Many of the areas in the basin have suffered serious population losses during the post World War II period. Much of this decline was associated with the declining fortunes of the coal and railroad industries. Areas such as Wilkes-Barre, Scranton, Altoona and Clearfield had severe population losses during the period from 1940-1960. However, during the period from 1960-1970 these areas have shown signs of recovery by reducing their out-migration. Additionally these areas have had some success at capturing new business and industry which have provided local employment opportunities. The lower Susquehanna River Basin contains nearly a third of the basin's overall population growth. This

region, including the Lancaster-Harrisburg-York metropolitan areas, has experienced significant population increases during the post World War II period. This region has been successful in maintaining and attracting new business and industry, therefore, it has been able to significantly increase its total population and economic base.

During the period from 1940-1970 the basin also experienced significant problems with its economic base which was heavily dependent upon industries such as mining textiles, railroads and agriculture. However, as was evidenced in the population data, there is also a wide disparity throughout the basin regarding the economic base. The lower Susquehanna River Basin and the New York portion have been relatively prosperous. The areas of Lancaster and York are major manufacturing centers. Harrisburg, as the state capital, has prospered from the growth of state government and has built a large service industry to support state government. The New York portion of the basin has also continued to prosper as a center of manufacturing. Major employers such as Ingersoll-Rand, Corning Glass and International Business Machines have contributed to the economic health of this area as a major manufacturing center. The remainder of the basin has suffered all of the economic ills associated with the declining mining and railroad industries. These areas have seen both high unemployment and outward migration of their population. A review of selected indicators such as labor force, total employment and per capita income indicates that most labor force increases have occurred in the Binghamton, Elmira and Harrisburg-Lancaster-York areas. Per capita income is the highest in the Harrisburg area ($3,266). The other areas of the basin have experienced declining labor force populations. The Williamsport subregion is the one exception. Due to the influence of the State College area and Pennsylvania State University, this region has shown a net increase in its labor force.

Agriculture remains an important factor in the basin's total economy. Total farm employment in the basin was estimated to be 64,700 persons in 1970. The largest amount of farm employment occurred in the lower Susquehanna River Basin. This area includes Lancaster County, which remains as one of the most productive agricultural counties in the United States. Leading agricultural commodities in the basin are milk products, vegetables and eggs. Beef and fruit commodities rank considerably lower in their output throughout the basin. However, many farms are falling out of production as there are increasing pressures for residential, commerical and industrial development.

The forests in the basin support an important wood products industry. Forests cover over 55 percent of the basin with over 90 percent of that timber being hardwood. Oak or the oak-hickory association accounts for 44 percent of the forest growth with beech, birch and maple species making up 27 percent. However, less than 25 percent of the hardwood stands will yield logs graded medium or better. In 1964, lumber production exceeded 330 million board feet, and pulpwood production was more than 400,000 cords. During this same period, employment in the lumber and wood products industry was 8,600 employees with an additional 12,700 employees in the pulp, paper and paperboard industry.

Mineral resources in the basin are dominated by the anthracite and bituminous coal deposits. Coal has been responsible for much of the economic depression throughout the coal mining areas of the basin. However, as the demand for coal has begun to increase, declining employment has leveled out. The recovery of bituminous coal has been far better than for anthracite coal. The higher costs of mining hard coal make it uncompetitive with soft coal for the purposes of electric power generation. Mine employment in the anthracite areas was approximately 3,800 in 1970. This reflects a continuing employment decline that is expected to continue. Presently, mine employment in the bituminous areas is also approximately 3,800. However, this employment level is expected to remain constant as the demand for bituminous coal increases. Besides coal, there are other mineral resources that are extensively mined in the basin. Sand, gravel, stone and clay are the leading mineral resources, other than coal, presently mined. In

1960, there were 10.5 million tons of sand and gravel and 22 million tons of stone produced. Clay production in 1960 accounted for only 1.7 million tons. Other mineral resources such as iron ore, copper, gold and silver are insignificant as mineral resources in the basin.

Development and Economy

Flood Damages: Since the time of the early settlers, development in the Susquehanna River Basin has occurred within the areas which are subject to periodic or occasional inundation from flood waters. Estimates of the level of damages which result have been made as early as the records of the flooding were kept. Much empircal data are available with regard to these historic flood damages. During the early 1960's, as part of the then on going comprehensive basin study, efforts were made to collect data and develop estimates for existing condition flood damage potential throughout the Basin. This available data was updated to reflect current price and development levels used in this study. This data base was augmented with more current data and damage estimates where these were available.

Estimates of damage were obtained by interview, generalized appraisal systems, or special studies for an individual property classification. In the few instances where it was impossible to make a current appraisal, data collected after recent floods and estimates used in previous reports were adjusted for current price levels and included in the damage summary.

Individual flood damage reaches have been established to include a length of stream in which hydraulic characteristics were relatively uniform. Stage-damage data were summarized for all communities that contained twenty-five or more affected properties and were aggregated by reach. Major urban damage centers were identified as separate reaches. The reaches are shown in Figure 7.

Flood damages were broadly classified as tangible damages (those that can be estimated in monetary terms) and intangible damages. Intangible flood damages are those detrimental effects of floods that cannot be given market or monetary values and include loss of human life, health, security, good will by business establishments, and adverse impacts on to national defense.

In the flood plains (up to approximately the flood of record plus five feet) of the main stem and major tributaries in the Susquehanna River Basin, there are approximately 90,000 non-agriculture buildings of which about 53 percent are within currently protected areas (Based on 1965 data). The remaining 47 percent have generally had a long history of frequent and serious flooding problems. To evaluate flood damages for each of these flood susceptible properties, and to remain within the time and monetary limitations imposed, a generalized approach to estimating flood damages was adopted. For this purpose, generalized flood damage appraisal systems were prepared to estimate damage to all properties other than industrial and non-typical commercial development for which individual on-site inspections and estimates were made. The report "Flood Damages, Susquehanna River Basin" prepared by the Baltimore District in 1969 details the procedures used to estimate the flood damages. A summary of the method used to estimate flood damage from the available data base is provided below.

Field surveys were made of all the flood plain locations during the early 1960's, and information for each structure was collected so that damages could be estimated. The residential and commerical properties appraised by use of the generalized systems were assembled by computer into the form of stage damage curves. A composite damage summary by class of property and type of damage was developed for each urban area containing twenty-five or more buildings affected by flooding. For each reach, composite stage-damage summaries were developed by relating all damage curves to a single index point.

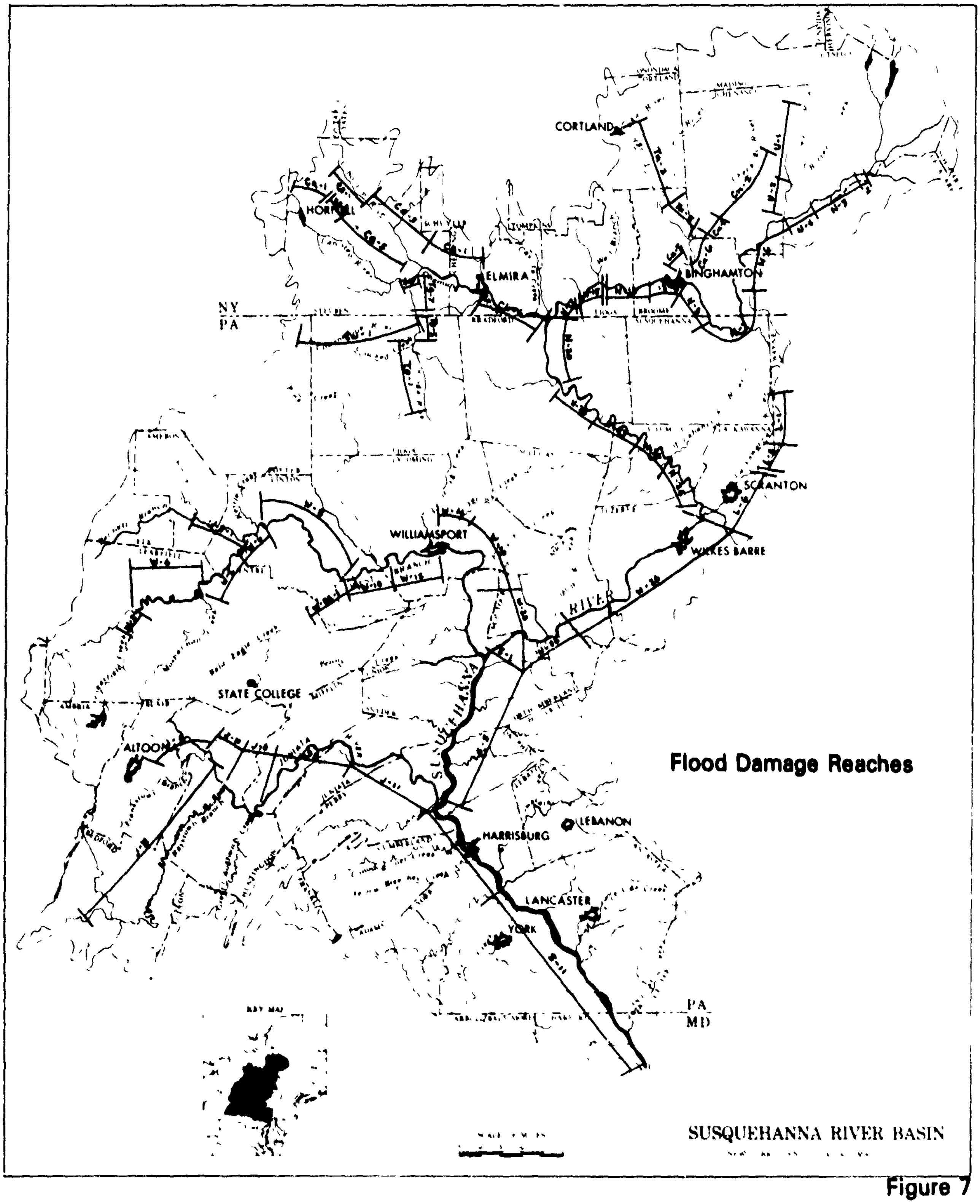

Flood Damage Reaches
SUSQUEHANNA RIVER BASIN
CORTLAND
HORNELL
ELMIRA
BINGHAMTON
NY
PA
SCRANTON
WILLIAMSPORT
WILKES BARRE
RIVER
SUSQUEHANNA
STATE COLLEGE
ALTOONA
HARRISBURG
LEBANON
LANCASTER
YORK
PA
MD

Figure 7

New field surveys were made for a limited number of locations in the Basin during 1974 and subsequently as a result of local flood protection studies for some urban areas. The most efficient means of accomplishing a basin-wide update of the remaining flood damage estimates was by inspection of current development levels in the flood prone areas by use of remote sensing. The current development levels were compared with development which was present at the time of the original field surveys. Factors were then applied to the original composite damage relationships to reflect the change in development and to bring the values up to current price levels.

Recent available aerial photographs were acquired and reviewed. Most of the reaches in the basin were updated using this procedure; however, recent aerial photographs were not available for some locations. Where remote sensing was not available to determine the current development level it was assumed to be unchanged. Only the price indices were applied to these locations.

Average annual damages were calculated by combining the composite stage-damage values with stage-discharge and discharge-frequency relationships developed for the appropriate gaging station to generate a damage-frequency relationship. The effects of both the existing projects and those in the pre-construction planning stage on the damage - frequency relationship were considered in determining the base condition average annual damages.

Many of the urban areas which are affected by flooding from the main stem or major tributaries are also subject to flooding from small streams which flow through the community and into the rivers. The damages that result from this flooding are in some cases quite significant. Because of the complexity of evaluating these effects at the present level of study they have not been included in the average annual damage values presented in Table 5.

It is estimated that average annual flood damages in the Susquehanna basin are $50 million at October 1977 price levels as shown in Table 5. Tropical Storm Agnes caused the worst flood on record for most of the basin with damages of about $3.5 billion. The March 1936 flood, the second worst flood on record, caused as estimated $55 million in damages. Destruction in the Baltimore District, reached about $3.5 billion and total losses in the United States exceeded $4 billion. Tropical Storm Agnes accounted for 95 fatalities within the District, and about 125 in the entire affected portions of the United States.

Water use: Currently there are nearly 600 public water supply systems in the Susquehanna River Basin. These systems service many industries and over 2,000,000 residents of the basin. There are also approximately 1,500,000 people dependent on individual sources, mostly ground water, in the rural areas of the basin (See Table 6).

Twenty-seven percent of the public water systems in this basin utilize surface water sources and 73 percent rely on ground-water sources.

The total demand for water supply in the basin during 1970 was approximately 3,200 mgd. The largest demand was for electric power cooling which represented 71 percent of the total demand. If electric power demands for surface water withdrawals are disregarded, ground-water withdrawals represent approximately 42 percent of the total amount of water used to satisfy all other demands in the basin. By the year 1990, preliminary estimates of demands for water supply are expected to exceed 5,500 mgd or an increase of some 72 percent in the 20-year period between 1970 and 1990. Anticipated reliance on ground-water sources are expected to continue well into this time frame.

TABLE 5

BASE CONDITION AVERAGE ANNUAL FLOOD DAMAGES FOR THE SUSQUEHANNA RIVER BASIN

(October 1977 Prices)

Reach Designation	Limits of Reach	Reference Gage	Average Annual Damages ($1000) Non-Agricultural	Agricultural
Susquehanna River above Binghamton: Sub-Area I-A				
N-1	Oneonta	Oneonta	$ 99	0
N-2	Oneonta to Otego Creek	Oneonta	11	17
N-3	Otego Creek to Ouleout Creek	Unadilla	25	10
N-4	Ouleout Creek to Unadilla River	Unadilla	381	23
N-5	Unadilla and Syndeyl	Unadilla	349	0
N-6	Unadilla River to Windsor	Bainbridge	42	55
N-7	Windsor to Great Bend	Conklin	65	13
N-8	Great Bend to Binghamton	Conklin	451	7
N-9	Conklin	Conklin	192	0
N-10	Kirkwood	Conklin	67	0
U-1	New Berlin to Butternut Creek	Bainbridge	126	49
U-2	Butternut Creek to Susq. R.	Rickdale	26	11
TOTAL	SUB-AREA I-A		$1,834	$185
Chenango and Tioughnioga Rivers: Sub-Area I-B				
Cn-1	Norwich		72	0
Cn-2	Norwich to Grenegantslet C.	Greene	62	11
Cn-3	Oxford	Oxford	0	0
Cn-4	Greene	Greene	24	0
Cn-5	Genegantslet Creek to Chenango Forks	Chenango Forks	88	6
Cn-6	Chenango Forks to Chenango Bridge	Chenango Forks	126	4
Cn-7	Chenango Bridge to Port Dickinson	Chenango Forks	114	0
Tn-1	Cortland	Cortland	388	0
Tn-2	Cortland to Otselic River	Marathon	733	44
Tn-3	Lisle	Marathon	8	0
Tn-4	Whitney Point	Itaska	0	0
Tn-5	Whitney Point to Chenago River	Itaska	54	3
TOTAL	SUB-AREA I-B		$1,669	$68

TABLE 5 (con't)
B \SE CONDITION AVERAGE ANNUAL FLOOD DAMAGES
FOR THE SUSQUEHANNA RIVER BASIN
(October 1977 Prices)

Reach Designation	Limits of Reach	Reference Gage	Average Annual Damages ($1000) Non-Agricultural	Agricultural
Susquehanna River Binghamton to Athens: Sub-Area I-C				
N-11	Binghamton	Vestal	75	0
N-12	Endicott, Johnson City Vicinity	Vestal	1778	0
N-13	Endicott to Owego	Vestal	421	20
N-14	Owego	Vestal	182	0
N-15	Owego to Nichols	Waverly	196	25
N-16	Nichols	Waverly	32	0
N-17	Nichols to Athens	Waverly	186	42
N-18	Sayre	Towanda	25	0
TOTAL	SUB-AREA I-C		$2,895	$87
Tioga Basin: Sub-Area II-A				
Tg-1	Blossburg to Tioga	Tioga	14	10
Tg-2	Blossburg	Blossburg	262	0
Tg-3	Mansfield	Tioga	0	0
Tg-4	Tioga	Tioga	0	0
Tg-5	Tioga to Lawrenceville	Tioga	101	0
Tg-6	Lawrenceville	Lindley	2	0
Tg-7	Lawrenceville to Cansisto River	Lindley	24	0
Tg-8	Cansisto River to Cohocton River	Erwins	65	0
Cw-1	Mills to Tioga River	Erwins	425	55
Cw-2	Elkland	Elkland	358	0
Ca-1	Arkport Dam to Nornell	W. Cameron	204	0
Ca-2	Hornell	W. Cameron	899	0
Ca-3	Hornell to Bennett Creek	W. Cameron	40	0
Ca-4	Canisteo	W. Cameron	36	0
Ca-5	Bennett Creek to Tuscarora C.	W. Cameron	86	11
Ca-5	Addison	Addison	2	0
Ca-7	Tuscarora C. to Tioga Creek	Addison	119	1
TOTAL	SUB-AREA II-A		$2,637	$77
Cohocton River: Sub-Area II-B				
Co-1	Rural	Bath	22	15
Co-2	Avoca	Bath	94	0
Co-3	Rural	Campbell	724	53
Co-4	Bath	Bath	57	0
TOTAL	SUB-AREA II-B		$897	$68

TABLE 5 (cont)
BASE CONDITION AVERAGE ANNUAL FLOOD DAMAGES
FOR THE SUSQUEHANNA RIVER BASIN
(October 1977 Prices)

Reach Designation	Limits of Reach	Reference Gage	Average Annual Damages ($1000) Non-Agricultural	Agricultural
Chemung River: Sub-Area II-C				
Ch-1	Rural			
Ch-2	Painted Post	Corning	13	0
Ch-3	Corning	Corning	20	0
Ch-4	Big Flats	Corning	1	0
Ch-5	Elmira	Elmira	364	0
Ch-6	Rural	Chemung	154	39
TOTAL	SUB-AREA II-C		$569	$64
Susquehanna River Athens to Pittson: Sub-Area III-A				
N-19	Athens	Towanda	359	0
N-20	Athens to Towanda	Towanda	59	50
N-21	Towanda	Towanda	3	0
N-22	Towanda to Wyalusing Creek	Towanda	175	30
N-23	Wyalusing C. to Meshoppen C.	Towanda	248	8
N-24	Meshoppen C. Tunkhannock C.	Towanda	126	10
N-25	Tunkhannock C. to Lackwanna River Wilkes-Barre	Towanda	157	4
TOTAL	SUB-AREA III-A		$1,127	$102
Lackwanna River: Sub-Area III-B				
L-1	Stillwater Dam to Jermyn	Carbondale	44	0
L-2	Carbondale	Carbondale	129	0
L-3	Jermyn to Olyphant	Archbald	463	0
L-4	Olyphant	Archbald	243	0
L-5	Scranton	Scranton	316	0
L-6	Olyphant to Moosic	Old Forge	57	0
TOTAL	SUB-AREA III-B		$1,252	$0
Susquehanna River Pittston to Sunbury: Sub-Area III-C				
N-26	Lackawanna R. to Fishing C.	Wilkes-Barre	1027	21
N-27	W. Pittston	Wilkes-Barre	1976	0
N-28	Swoyersville & Forty Fort	Wilkes-Barre	749	0
N-29	Kingston & Edwardsville	Wilkes-Barre	4631	0
N-30	Wilkes-Barre	Wilkes-Barre	5658	0
N-31	Plymouth	Wilkes-Barre	567	0
N-32	Nanticoke	Wilkes-Barre	12	0
N-33	Shickshinny	Wilkes-Barre	128	0
N-34	Bloomsburg	Danville	304	0
N-35	Danville	Danville	455	0
N-36	Fishing C. to West Branch	Danville	443	18
TOTAL	SUB-AREA III-C		$15,950	$39

TABLE 5 (con't)
BASE CONDITION AVERAGE ANNUAL FLOOD DAMAGES
FOR THE SUSQUEHANNA RIVER BASIN
(October 1977 Prices)

Reach Designation	Limits of Reach	Reference Gage	Average Annual Damages ($1000) Non-Agricultural	Agricultural
West Branch above Renovo: Sub-Area IV				
W-1	Curwensville	Curwensville	551	0
W-2	Curwensville To Clearfield	Clearfield	136	0
W-3	Clearfield	Clearfield	149	0
W-4	Clearfield to Moshannon C.	Karthas	3	0
W-5	Moshannon C. to Sinnemahoning C.	Karthas	238	0
W-6	Sinnemahoning C. to Kettle C.	Renovo	26	0
W-7	Renovo	Renovo	253	0
TOTAL	SUB-AREA IV		$1,356	$0
West Branch Renovo to Sunbury: Sub-Area V				
W-8	Kettle Creek to Lock Haven	Lock Haven	573	2
W-9	Lock Haven	Lock Haven	3,756	0
W-10	Lock Haven to Pine Creek	Jersey Shore	71	17
W-11	Jersey Shore	Jersey Shore	244	0
W-12	Pine Creek to Lycoming Creek	Jersey Shore	145	22
W-13	Williamsport	Williamsport	1516	-
W-14	Lycoming C. to White Deer C.	Williamsport	254	7
W-15	Muncy	Muncy	559	-
W-16	Montgomery	Montgomery	191	-
W-17	Loyalsock C. to White Deer C.	Montgomery	108	21
W-18	Milton	Milton	1127	-
W-19	Lewisburg	Lewisburg	316	-
W-20	White Deer C. to Northumberland	Lewisburg	548	39
W-21	Northumberland	Lewisburg	26	-
TOTAL	SUB-AREA V		$9,434	$108
Little Juniata and Frankstown Branch: Sub-Area VI-A				
J-C	Altoona to Juniata River		275	3
J-D	Williamsburg	Williamsburg	388	0
J-E	Williamsburg to Juniata River	Williamsburg	1159	17
J-2	Tyrone	Williamsburg	36	0
TOTAL	SUB-AREA VI-A		$1,858	$20

TABLE 5 (con't)
BASE CONDITION AVERAGE ANNUAL FLOOD DAMAGES
FOR THE SUSQUEHANNA RIVER BASIN
(October 1977 Prices)

Reach Designation	Limits of Reach	Reference Gage	Average Annual Damages ($1000) Non-Agricultural	Agricultural
Juniata and Raystown Branch: Sub-Area VI-B				
J-A	Bedford	Bedford	33	0
J-1	Everett	Everett	155	0
J-B	Bedford to Juniata River	Bedford	333	6
J-F	Little Juniata R. to Raystown Branch	Huntingdon	321	2
J-3	Huntingdon	Huntingdon	121	0
J-4	Smithfield Township	Huntingdon	193	0
J-5	Mount Union	Mapleton Depot	5	0
J-6	Raystown Branch to Aughwick Creek	Mapleton Depot	107	2
J-7	Lewistown	Lewistown	369	0
J-8	Mifflin	Mifflin	11	0
J-9	Aughwick C. to Tuscarora C.	Lewistown	200	1
J-10	Newport	Newport	61	0
J-11	Tuscarora C. to Susq. R.	Newport	215	5
TOTAL	SUB-AREA VI-B		$2,124	$16
Susquehanna River Sunbury to Harrisburg: Sub-Area VII				
S-1	Sunbury	Sunbury	845	0
S-2	Selinsgrove	Selinsgrove	92	7
S-3	West Branch to Juniata River	Selinsgrove	638	0
S-4	Duncannon	Duncannon	100	0
S-9	Juniata R. to Conewago C.		267	0
TOTAL	SUB-AREA VII		$1,942	$7
Susquehanna River below Harrisburg: Sub-Area VIII				
S-5	Harrisburg	Harrisburg	$2,191	0
S-6	New Cumberland	New Cumberland	127	0
S-7	Steelton	New Cumberland	704	0
S-8	Middletown & Royalton	Middletown	231	0
S-9	Juniata R. To Conewago C.		267	0
S-10	Marietta	Marietta	110	0
TOTAL	SUB-AREA VIII		$3,630	$0
SUSQUEHANNA RIVER BASIN TOTAL DAMAGES			$49,174	$841

The distribution of demand for water supply is well scattered throughout the basin. However, primary locations of extreme demands are anticipated in the southern portion of the basin in the Harrisburg, Lancaster, York area and the surrounding principal metropolitan areas of Binghamton.

The combined effects of withdrawals from both surface and ground-water sources and the resultant consumptive losses have both interstate and intrastate effects. The water supply demands and losses of individual industries, communities and individual users are accrued by watersheds with each directly linked to downstream water availability. Demands and losses in the New York State portion of the basin have direct influences on the Pennsylvania portion of the basin. Likewise all of the upstream demands and losses have direct impacts on the freshwater inflow into the upper Chesapeake Bay. The locations of the increased demand for an additional 2,300 mgd by 1990 and its related consumptive losses are of concern, since the location and effects of these demands and losses may have serious adverse impacts, interstate, and intrastate consequences. The production of electric power is the largest single water withdrawal item in the basin and is projected to increase its percentage of use from 71 percent in 1970 to 76 percent in 1990. If projected electric power production requirements are to be met by the use of the Susquehanna River Basin's water resources, then the location of the facilities either in scattered sites or clustered together in power centers and their respective withdrawal rates and consumptive losses are extremely critical to the basin's water resources. In addition, the demand for maximum electric power usage occurs in the summer season when surface and ground-water flows are at or approaching their lowest level. Total withdrawal rates and consumptive losses are particularly significant since there is a lack of basin-wide information related to the interrelationships between ground-water and surface flows. In addition there are hazards of not only water quantity problems, but also water quality degradation due to the over-development of the resources leading to a potential lack of assimilative capacities. All of these factors must be explored to determine the effects of water availability throughout the basin and to evaluate the freshwater inflow into the upper Chesapeake Bay. Susquehanna River flows constitute 85 percent of the freshwater inflow to the upper bay and therefore significant changes in the flow regime affect the upper bay's salinity and ecology.

In recent years the consumptive usage of water drawn from the river and its tributaries has become an issue of increasing concern. Projections and anticipation of unknown increases in demand have generated the need for protecting the rivers flow from being greatly decreased during low flow periods. To provide protection, the Susquehanna River Basin Commission (SRBC) adopted a regulation in September 1976 which requires consumptive users of water within the basin to provide for make-up of their usage during low flow periods. The regulation states "Compensation in an amount equal to the user's total consumptive use shall be required when the streamflow at the point of taking equals or is anticipated to equal the low flow criterion which is the 7-day 10-year low flow plus the projects total consumptive use and dedicated augmentation". The regulation as enacted applies to not only withdrawals from surface waters but also from ground-water sources which are "hydraulically related to stream flows". The restrictions adopted by the SRBC apply to all consumptive uses initiated since 23 January 1971, the date the Commission was created.

Power Supply: In the assembly and analysis of statistics on power requirements and supply for the electric utility industry the Federal Energy Regulatory Commission has found it convenient to divide the country into Power Supply Area's or PSA's. Generally, a PSA embraces the service territories of those interconnected utility systems which operate with a certain degree of coordination as an essentialy self-sufficient group, independent of adjacent systems. Over the years there has been a continuing trend to expand interconnections among systems and increased coordination of power planning and operations between adjacent PSA's.

TABLE 6

DOMESTIC WATER USE CHARACTERISTICS IN THE SUSQUEHANNA RIVER BASIN

State and Subbasin	Total Population (1000)	Total No. of Public Water Supply Systems	Sources			Population Served (1000)		Self Supplied Domestic (1000)	Total GW Sources (1000)	Percent
			Surface	GW	Total	Surface	GW			
New York										
Eastern	452	112	34	78	256	100	156	196	352	78%
Chemung	210	32	8	24	142	84	58	68	126	60%
SUBTOTAL	662	144	42	102	598	184	214	264	478	72%
Pennsylvania										
Main Stem Sus. R.	2,094	271	60	211	1,230	1,008	222	864	1,086	52%
W. Br. Sus. R.	417	96	32	64	225	148	77	192	269	65%
Juniata River	292	60	18	42	158	135	23	134	157	54%
SUBTOTAL	2,80[illegible]	427	110	317	1,613	1,291	322	1,190	1,512	54%
Maryland SUBTOTAL	60	7	3	4	15	10	5	35	40	67%
TOTAL	3,525	578	155	423	2,016	1,485	541	1,489	2,03[illegible]	58%

The market area selected from this study consists of PSA's 5 and 6, which encompass the service territories of all the utilities forming the Pennsylvania-New Jersey-Maryland Interconnection, a fully coordinated power pool known as PJM; the south central portion of the New York State Electric & Gas Corporation in PSA 3, a member of the New York Power Pool; and the Keystone and Nittany Divisions of West Penn Power Company in PSA 7, a member of the Allegheny Power System. The market includes all of the Susquehanna River Basin and parts of the Allegheny, Delaware, Hudson, and Potomac River Basins.

Served by 94 utilities, energy requirements in the Susquehanna River Basin Market in 1976 totalled 163.4 billion kilowatt-hours with an associated coincidental summer peak demand of 30 million kilowatts and an annual load factor of 61.9 percent. The 76 publicly owned utilities accounted for 5.4 billion kilowatt-hours, or 3.3 percent of the total market requirements; and 18 privately owned utilities, 158 billion kilowatt-hours, or 98.9 percent of the total market. Of the 94 utilities, 34 have energy requirements greater than 100 million kilowatt-hours, accounting for 98.9 percent of the market load.

The market is served by an extensive transmission network of several voltage levels including 115 kV, 138 kV, 230 kV, 345 kV, and 500 kV. The utilities in the market area also have numerous interconnections with systems in neighboring areas. Proposed future facilities provides for expansion of the existing bulk power supply network and additional interties.

Recreation Resources: Appendix G, Part I, of the 1970 Susquehanna River Basin Study entitled General Recreation, prepared by the Recreation Subcommittee under the chairmanship of the Bureau of Outdoor Recreation, (presently HCRS) presented an analysis of the water-oriented recreation needs of the Susquehanna River Basin. The present and future market area demand for non-urban water-oriented outdoor recreation was measured along with the existing and prospective supply of recreation resources. Additional development of the existing resource was analyzed and from this analysis, the general non-urban water-oriented outdoor recreation needs of the basin were estimated.

At the time of the investigation it was estimated that there were approximately 101,400 surface acres of water within the basin of which an estimated 64,800 acres were accessible to the general public. Because the basin lies adjacent to the most densely populated area of the country, which extend from Boston, Massachusetts to Washington, D.C., the recreation market area is a very large (Figure 8) with an estimated population (1960) of approximately 34 million people. From this population figure the effective recreating population of the basin was estimated to have been 3.9 million. This effective recreating population or that portion of the market area expected to use the basins recreational facilities was projected to increase to 5.4 million in 1980, to 7.5 million in 2000 and to 10.8 million in 2020. Recent population figures obtained from the 1972 OBERS Projections, Regional Economic Activity in the U.S. Series E Population, Vol. 2-BEA Economic Areas, which generally provides a more conservative analysis, indicates that the basin's market will increase approximately 43 percent from the current 53.5 to 76.7 million by the year 2020. The effective recreating population with these population projections was calculated to be 5.9 million in 1970, 6.5 million in 1980, 7.6 million in 2000 and 8.6 milion in 2020. A comparison of these figures indicates that the more recent figures would not significantly alter the projected effective recreating population, thus those recreation figures developed in the 1970 Susquehanna River Basin Study would be appropriate for the current investigation.

The 64,800 surface acres of water accessible to the public in 1960 had an estimated seasonal capacity of 25 million water-oriented recreation days. The estimated demand for that year was 28.3 million water-oriented recreation days based upon a per capita participation rate of 7.3. Assuming the combined effects of increasing income, place of residence, more leisure time, and


Cooperstown
Elmira
Binghamton
Athens
Scranton
Williamsport
Lock Haven
Sunbury
Altoona
Harrisburg

Figure 8

a redistribution of the population within age and education classes. The per capita participation rate was projected to increase 40 percent by 1980 to 10.2, 78 percent by 2000 to 13.0 and 100 percent to 14.6 by 2020. These increased per capita participation rates combined with an increase in the acreage of accessible water, leads to the estimated basin demands of 54.6 million water-oriented recreation days in 1980, 96.9 million in 2000 and 154.7 million in 2020. Additional water projects programmed for development by 1980 will increase the total surface area to 116,800 acres of which 68 percent or 79,800 acres will be accessible to the public. It was estimated that these public waters will have a summer seasonal capacity of 28.9 million recreation days in 1980, 33.8 million recreation days in 2000 and 38.5 million recreation days in 2020 based primarily upon increased utilization as opposed to increased acreages as it was assumed the total acreage of publicly available water would not change beyond 1980.

Existing Plans and Improvements

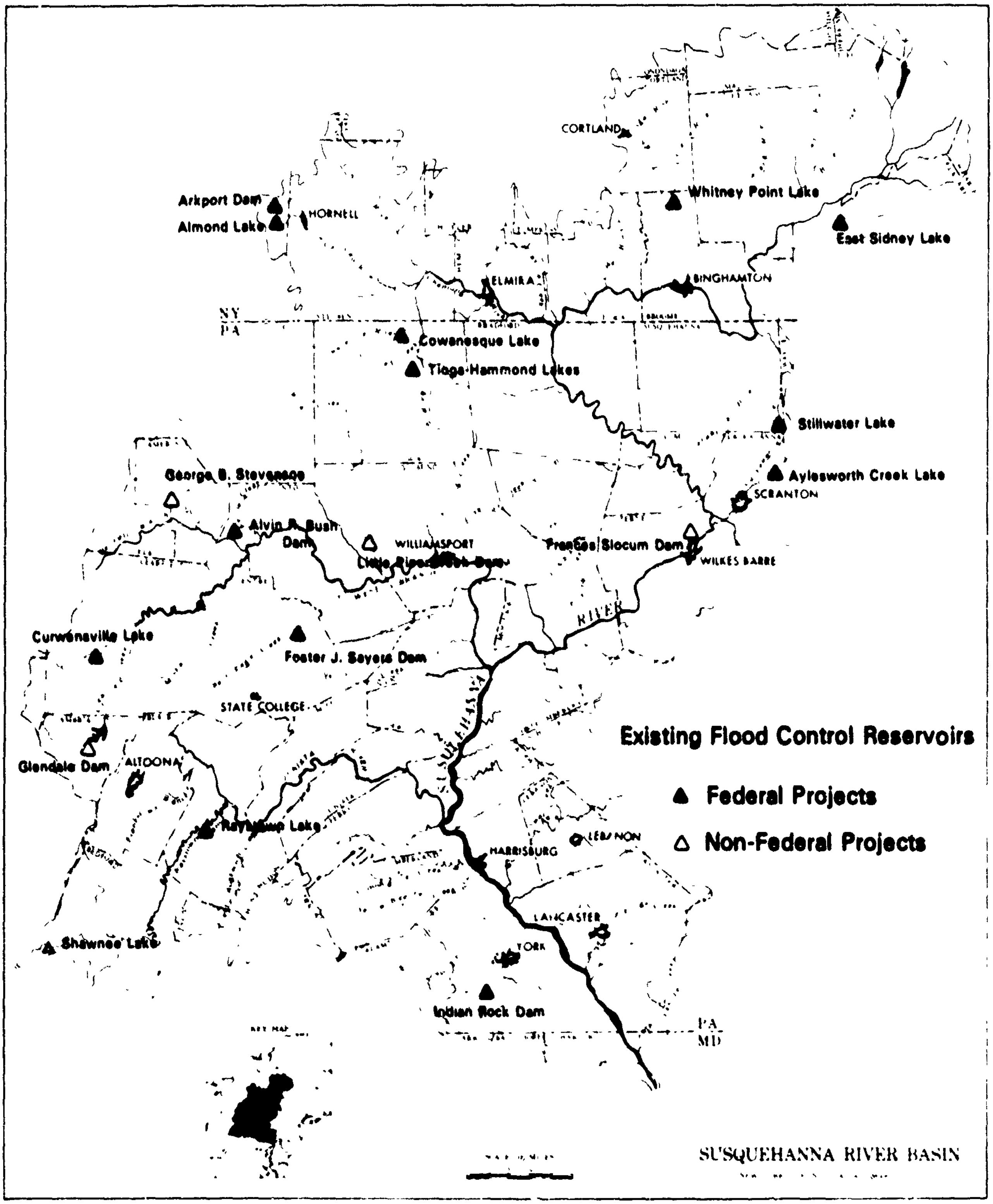
Through the years many flood control projects have been constructed by the Federal and state governments. These improvements consist of major reservoirs, upstream watershed projects, and local flood protection projects.

Reservoirs: The Corps of Engineers and the Commonwealth of Pennsylvania have constructed 19 major reservoirs within the basin containing flood control storage and two are currently under construction. In addition, there are five reservoirs located in New York state which were authorized but have not been constructed because of strong opposition, and have been recommended for deauthorization. Tables 7 and 8 list the Federal and state projects and their status, and Figure 9 shows the location of the projects constructed or currently under construction. The States of New York and Maryland have not constructed any flood control reservoirs in the basin. As noted in Table 7 nearly all of the completed reservoirs are multiple-purpose, providing in most cases a summer pool for recreation. The total drainage area controlled by the completed and authorized Federal and non-Federal flood control reservoirs is about 4,229 square miles or approximately 15 percent of the total area of the basin. These reservoirs include over 1,200,000 acre-feet of flood control storage.

Upstream Watershed Projects: Public Law 83-566 (68 Stat. 666), the Watershed Protection and Flood Prevention Act, authorizes the Secretary of Agriculture to assist in the development of water resources. The act provides for technical, financial, and credit assistance when a project type approach is used on upstream watershed areas. Initiative and responsibility must be exercised by the local people. Projects may include conservation measures such as erosion and sedimentation control as well as structural measures such as dams for flood protection, water supply, recreation, fish and wildlife enhancement, agricultural water development, and related purposes. Multiple purpose projects are encouraged through a system of works of improvement and land use and management practices.

Prior to enactment of PL 83-566, several upstream watersheds were authorized under PL 74-46. These "pilot" projects had the same objectives, assistance, structural measures, and provisions for cost sharing as PL 83-566 projects. In the Susquehanna River Basin there have been fifteen upstream watershed projects authorized for construction. All of these are either completed or in various stages of construction. There are four additional Watershed Work Plans which are currently being prepared. Table 8 lists the relative size and principle features of each project and Figure 10 shows their location.

Local Flood Protection Projects: The Corps of Engineers, the State of New York, and the Commonwealth of Pennsylvania have constructed 61 local projects in the Susquehanna River Basin. These projects include levees, flood walls, pressure conduits, spoil dikes, interceptor



Existing Flood Control Reservoirs
Federal Projects
Non-Federal Projects
SUSQUEHANNA RIVER BASIN
Arkport Dam
Almond Lake
HORNELL
CORTLAND
Whitney Point Lake
East Sidney Lake
ELMIRA
BINGHAMTON
NY
PA
Cowanesque Lake
Tioga-Hammond Lakes
Stillwater Lake
Aylesworth Creek Lake
SCRANTON
George B. Stevenson
Alvin R. Bush Dam
WILLIAMSPORT
Frances Slocum Dam
WILKES BARRE
RIVER
Curwensville Lake
Foster J. Sayers Dam
STATE COLLEGE
Glendale Dam
ALTOONA
Raystown Lake
HARRISBURG
LEBANON
LANCASTER
YORK
Shawnee Lake
Indian Rock Dam
PA
MD

Figure 9

TABLE 7 FEDERAL FLOOD CONTROL DAM AND RESERVOIR PROJECTS

Name	Stream	Purpose	Drainage Area Sq. Mi.	Height Feet	Max. Flood Cont. Stor. Acre Ft.
1. Federal					
East Sidney	Ouleout Creek	FC, R	102	130	31,750
Whitney Point	Otselic River	FC, R	255	95	81,400
Almond	Canacadea Creek	FC, R	56	90	14,240
Arkport	Canisteo River	FC	30.5	113	7,950
Stillwater	Lackawanna River	FC, WS	36.8	77	11,657
Alvin R. Bush Dam-Kettle Creek Reservoir	Kettle Creek	FC, R	226	165	73,410
Curwensville	W. Br. Susq. R.	FC, R	365	131	119,060
Indian Rock	W. Br. Codorus Creek	FC	93.7	83	28,000
Foster Joseph Sayers	N. Bald Eagle Cr.	FC, R	339	100	92,700
Aylesworth	Aylesworth Creek	FC	6.2	90	1,700
Raystown	Raystown Branch Juianta River	FC, R	960	225	248,000
<u>Under Construction</u>					
Tioga-Hammond	Tioga River and Crooked Creek	FC, R	280(T)	140(T)	120,064
Cowanesque	Cowanesque River	FC	298	154	95,490
<u>Authorized but Unconstructed</u>					
Davenport Center	Charlotte Creek	FC	164	100	52,500
West Oneonta	Otego Creek	FC	108	86	34,500
Copes Corner	Butternut Creek	FC	118	75	37,900
Genegantslet	Genegantslet Creek	FC	95	100	30,195
South Plymouth	Connsawocta Creek	FC	58	125	18,500
2. State					
Frances Slocum Dam	Abrahams Cr.	FC	6.1	51	2,400
George B. Stevenson Dam	First Fork Sinnemahoning Creek	FC, R	243.0	166	73,200
Little Pine Creek Dam	Little Pine Creek	FC, R	165.4	113	23,700
Shawnee Lake	Shawnee Cr.	FC, R	37.5	56	13,200
Glendale Dam Prince Gallitzin State Park	Beaver Dam Run	FC, R	42	60	15,900

FC - Flood Control
R - Recreation
WS - Water Supply

TABLE 8 UPSTREAM WATERSHED PROJECTS

Project Name	Project Size (Acres)	Purpose 1/	Single Purpose Flood Prevention Dams (No.)	Multiple Purpose Flood Prevention (No.)	Channel Improvement Dike and Levees	Other
Corey Creek	15,424					
Dean Creek	6,320		2		Channel imp.	11 debris basins
Great Brook	16,768		1		Channel imp.	2 debris basins road bank stabilization
Briar Creek	9,344	Recreation	1	1		recreation facilities
Genegantslet Creek	66,457	Fishery enhancement	1		50 mi. trout stream imp.	1 single purpose wildlife structure
Little Choconut, Finch Hollow Trout Brook	12,276		7			
Little Deer Creek	10,112		4			
Marsh Creek	55,000	Water supply, recreation	1	2		recreation facilities
Marsh Ditch	14,560				4.7 mi. channel imp.	3 drop structures and 3 triburary grade control measures
Martins Creek	31,680		2			1 floodwater diversion
Middle Creek	84,200	Water supply, recreation		3		recreation facilities
Mill Brook	2,950	Recreation	1	1	Channel imp.	
Mill Creek	8,430	Fishing	2	1		
Nanticoke Creek	73,000	Fish and Wildlife	9	1	Dike & levee channel imp.	1 single purpose fish and wildlife structure
Nescopeck Creek	48,900	Recreation		1		recreation facilities
Newton-Hoffman Creeks	54,600	Fishing	6	1	Floodway channel imp.	1 debris basin, dike reinforcing, and a pumping plant

TABLE 8 UPSTREAM WATERSHED PROJECTS (cont)

Project Name	Project Size (Acres)	Purpose 1/	Single Purpose Flood Prevention Dams (No.)	Multiple Purpose Flood Prevention (No.)	Channel Improvement Dike and Levees	Other
North Fork of the Cowanesque River	7,650		1			
Patterson, Brixius, Grey Creek	8,000		1			
Upper Five Mile Creek	38,100				Dike & levee stream imp. pumping plant	1 debris basin, 1 drainage structure

1/ All projects have sediment and erosion control and flood prevention as a primary purpose and all projects include adequate land treatment program

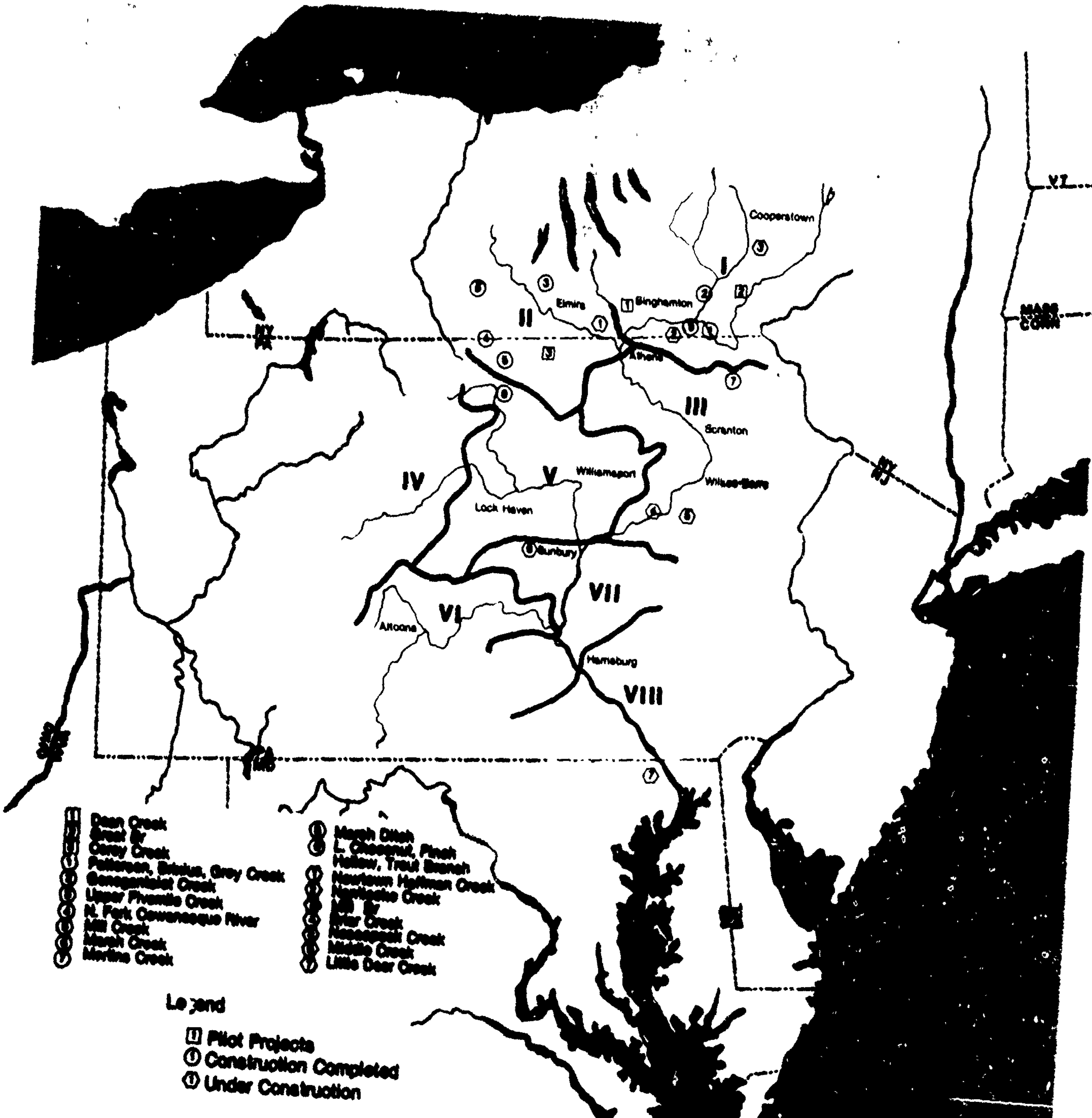

Cooperstown
Elmira
Binghamton
Athens
Scranton
Williamsport
Wilkes-Barre
Lock Haven
Sunbury
Altoona
Harrisburg
I
II
III
IV
V
VI
VII
VIII
Legend
Pilot Projects
Construction Completed
Under Construction

Figure 10

TABLE 9 LOCAL FLOOD PROTECTION PROJECTS

FEDERAL PROJECTS

Location	Stream	Type of Project	Length (Ft.)	Design Discharge (cfs)
1. Federal Projects				
Hornell, NY	Canisteo R.	Levee, Wall	57,850	21,000
	Canacadea R.	Channel Imp.		8,000
	Crosby Cr.			5,000
	Chauncey Run			3,000
Painted Post, NY	Chemung R.	Levee, Wall	14,700	115,000
	Cohocton R.	Chan. Imp.		60,000
Kingston	Susq. R.	Levee	28,168	232,000
Edwardsville, PA	Toby Cr.	Pres. Cond.		4,000
Plymouth, PA	Susq. R.	Levee, Chan.	11,350	232,000
	Coal Cr.	Diversion		5,600
Scranton, PA	Lackawanna R.	Levee, Wall		35,000
Swoyersville-Forty Fort, PA	Susq. R.	Levee, Sheetpile,	23,360	232,000
	Abrahams Cr.	Chan. Diversion		4,000
Wilkes-Barre,	Susq. R.	Levee, Wall	28,020	232,000
Hanover Twshp., PA	Solomon Cr.			10,000
Addison, NY	Canisteo R.	Levee, Wall	9,900	32,000
	Tuscarora Cr.	Levee, Wall	700	15,000
	Tuscarora Cr.	Bank Prot.	6,500	—
Avoca, NY	Cohocton R.	Levee, Chan.	13,000	37,800
	Salmon, Cr.	Imp.	8,300	8,500
Bath, NY	Cohocton R.	Levee, Wall	11,650	36,000
Canisteo, NY	Canisteo R.	Levee,	16,400	31,000
	Bennett Cr.	Chan. Imp.		15,000
Corning, NY	Chemung and	Levee, Wall	46,300	115,000
	Cohocton R.	Chan. Imp		
	Monkey Run	Chan. Imp.	4,330	2,500

TABLE 9 LOCAL FLOOD PROTECTION PROJECTS (cont)

Location	Stream	Type of Project	Length (Ft.)	Design Discharge (cfs)
Elkland, PA	Cowanesque River	Levee Chan. Imp.	18,750	39,000
Elmira, NY	Chemung R. Newton Cr. Seely Cr. Hoffman Brook	Levee, Wall Conduit, Sewer Chan. Imp.	76,800	115,000
Brainbridge, NY	Newton Cr.	Chan. Imp	2,335	2,500
Binghamton, NY	Susq. R. Chenango R.	Levee, Flood Wall, Chan. Imp., Pres. Conduit	22,335 13,100 3,100 1,060	80,000 75,000
	Chenango R.	Clearing & Snagging	1,100	---
Cincinnatus, NY	Otselic R.	Clearing & Snagging	5,280	---
Conklin-Kirkwood NY	Susq. R.	Chan. Imp.	37,000	---
Cortland, NY	Tioughnioga R.	Chan. Imp.	14,200	5,200
Endicott,		Levee, Flood	39,400	126,000
Johnson City,		Wall, Chan.	2,800	
Vestal, NY	Susq. R.	Imp.		
Greene, NY	Birdsall Cr.	Levee	2,400	1,200
Lisle, NY	Tioughnioga R. Dudley Cr.	Levee, Flood Wall, Chan. Imp.	4,150 970 8,700	52,000 18,000
Nichols, NY	Susq. R. Wappasening Cr.	Levee	9,700 32,000	145,000
Norwich, NY	Chenango	Chan. Imp.	9,000	4,000
Oneonto, NY	Susq. R.	Chan. Imp.	1,500	---
Owego, NY	Owego Cr.	Clearing & Snagging	9,000	
Oxford, NY	Chenango Cr.	Levee	2,100	30,000
Port Dickinson, NY	Chenango R.	Clearing & Snagging	2,100	

TABLE 9 LOCAL FLOOD PROTECTION PROJECTS (Cont)

Location	Stream	Type of Project	Length (Ft.)	Design Discharge (cfs)
Sherborne, NY	Chenango R.	Clearing & Snagging	10,560	----
Unadilla, NY	Martin Brook	Chan. Imp.	3,300	3,000
Whitney Point Village, NY	Tioughnioga R.	Levee,	7,100	57,000
		Chan. Imp.	1,800	
Milton, PA	W. Br. Susq. River	Clearing & Snagging	---	---
Williamsport, PA	W. Br. Susq. R.	Levee, Wall	76,505	264,000
	Lyoming Cr.	Culvert, Flume		40,000
	Hagermans Run			2,700
	Millers Run			10,000
	Grafius Run			2,000
Tyrone, PA*	Little Juniata River	Levee, Wall	---	40,300
	Bald Eagle Cr.	Chan. Diversion & Imp.		13,400
Sunbury, PA	Susq. R.	Levee, Wall	26,100	556,000
	Shomokin Cr.			16,000
York, PA	Codorus Cr.	Levee, Wall Chan. Imp.	22,969	24,000

TABLE 9 LOCAL FLOOD PROTECTION PROJECTS (cont)

NON-FEDERAL PROJECTS

Location	Stream	Type of Project	Length (Ft.)
Sayre, PA	Susquehanna R.	Levee	4,700
	Cayuta Cr.	Chan. Imp.	1,800
	Susquehanna R.	Inter. Drains & Pump Sta.	1,580
Athens, PA	Susquehanna R.	Levee	100
	Chemung R.	Levee	4,100
Tioga, PA	Tioga R.	Levee	9,800
		Chan. Imp.	8,000
Gang Mills, NY*	Tioga R. Cohocton R.	Levee	16,300
Dickson City, PA	Old Dam Cr.	Chan. Imp.	545
Duryea, PA	Lackawanna R.	Chan. Imp.	4,500
Mayfield	Lackawanna R.	Chan. Imp.	26,000
Olyphant		Spoil Dikes	9,000
McAdoo	Celebration C.	Chan. Imp.	5,260
Mocanaqua, PA	Turtle Cr.	Chan. Imp.	810
Moosic, PA	Lackawanna R.	Levee	2,700
	Spring Run	Levee	650
	Spring Brook	Levee	4,900
		Chan. Imp.	3,450
Plymouth, PA	Wadham Cr.	Debris Dam,	
	Duffy Run	Culvert,	1,800
		Debris Dam	
	Brown Cr.	Culvert	1,800
Scranton, PA	Lackawanna Cr.	Chan. Imp.	2,800
	Roaring Brook	Culvert	2,600
		Chan. Imp.	
	Stafford Meadow Brook	Chan. Imp.	1,925
Wyoming, PA	Abrahams Cr.	Chan. Imp.	4,800

TABLE 9 LOCAL FLOOD PROTECTION PROJECTS (cont)

Location	Stream	Type of Project	Length (Ft.)
Danville, PA	Susquehanna R.	Levee	3,000
		Raise Exist Levee	1,300
	Mahoning Cr.*	Chan. Imp. and Levee	4.000
	Sechler Run	Chan. Realignment	
Barnesboro, PA	W. Br. Susquehanna R.	Levee	5,200
		Chan. Imp.	7,800
Cherry Tree, PA	W. Br. Susquehanna R.	Levee	5,300
		Chan. Imp.	5,000
Emporium, PA	Plank Road	Debris Dam	960
	Hollow Run	Chan. Imp.	
Irvona, PA	Clearfield Cr.	Levee	9,800
	Witmer Run	Levee	1,750
Patton, PA	Chest Cr.	Chan. Imp.	9,350
	Plannigan Run	Chan. Imp.	6,300
Philipsburg, PA	Moshannon Cr.	Chan. Imp.	2,800
		Chan. Imp.	6,300
Galeton, PA	Pine Cr.	Levee, Chan. Imp.	3,400
Milesburg, PA	Bald Eagle Cr.	Chan. Imp.	3,750
	Moose Run	Chan. Imp.	2,000
Milton, PA	W. Br. Susquehanna R.	Stabilization	670
Everett, PA	Raystown Br. Juniata R.	Levee	5,500
Huntingdon -	Crooked Cr.	Chan. Imp.	1,200
Smithfield, PA	Lily Cr.	Conduit, Debris Dam	1,772
	Juniata R. (Huntingdon* Side)	Levee	2,000
	(Smithfield Side)	Levee	3,700
	Crooked Cr.*	Levee	3,000

* Under Construction

sewers, culvets, pumping stations, and channel improvements. In most cases, these local protection projects are designed to protect against at least the largest flood of record, with additional capacity to protect against overtopping the structure. Table 9 list the Federal and non-Federal projects and their status.

Phase I of advanced Engineering and Design for projects in Lock Haven and Wyoming Valley Pennsylvania was authorized in October 1976 by the Water Resources Development Act (PL 94-587). The Phase I studies for Lock Haven and Wyoming Valley were initiated in October 1977 and are scheduled for completion in August 1980 and August 1981, respectively.

In December 1977 a survey report for the local flood protection project at Harrisburg, Pennsylvania was completed by the Baltimore District. The report recommends a channel improvement, levee and floodwall project for the Paxton Creek area and South Harrisburg. No Federal project is recommended for North Harrisburg. The report is currently under review in Washington, D.C.

Construction of a local flood protection project in Loyalsock Township, Pennsylvania was authorized by the Chief of Engineers in December 1976. The project is being constructed under the Small Flood Control Project Program.

A detailed project report has been initiated for the community of Pine Grove, Pennsylvania under the Small Flood Control Projects Program. This report is scheduled for completion in Fiscal Year 1981.

Effectiveness of Federal Projects: The preceding paragraphs have discussed existing Federal flood control projects in the Susquehanna River Basin. These improvements have been extremely effective in reducing flood damages in the basin. The cumulative total estimate of flood damages prevented by Federal projects through fiscal year 1979 is $2.2 billion. Table 10 presents a summary of the cumulative damages prevented by project.

TABLE 10
Cumulative Damage Prevented by Federal Projects ($1,000's through FY 1979)

Project	Cumulative Damages Prevented
Almond Lake	$66,878
Arkport Dam	19,322
East Sidney Lake	54,409
Whitney Point Lake	210,196
Addison	4,553
Avoca	1,578
Bainbridge	30
Bath	5,123
Binghamton	88,771
Canisteo	3,333
Conklin-Kirkwood	375
Corning	42,972
Cortland	1,091
Elmira	66,091
Endicott-Johnson City - Vestal	19,598
Greene	80
Hornell	34,605

TABLE 10 (cont)
Cumulative Damage Prevented by Federal Projects ($1,000's through FY 1979)

Project	Cumulative Damages Prevented
Lisle	1,797
Nichols	2,835
Norwick	209
Owego	60
Oxford	282
Painted Post	18,294
Whitney Point Village	4,380
Indian Rock - Codorous Creek	52,180
Curwensville	48,721
Bush Dam	124,663
Sayers Dam	70,570
Raystown Lake	65,857
Stillwater Lake	14,213
Elkland	1,000
Tioga-Hammond Lakes	12,209
Cowanesque Lake	4,660
Kingston - Edwardsville	228,538
Plymouth	31,874
Sunbury	97,153
Swoyersville - Forty Fort	137,087
Wilkes Barre - Hanover Township	477,919
Williamsport	212,202
Aylesworth	140
TOTAL	$2,225,848

FUTURE CONDITIONS

The purpose of this section is to briefly present a summary of the possible future conditions of the study area.

Basin Flood Trends

Man's occupation of the flood plains in the Susquehanna Basin has left him vulnerable to damages and loss of life. This use of the flood plains must be viewed from a historical perspective. The early settlers were attracted to the Basin's flood plains because rich farmlands were readily available in the river valleys, and the streams provided easy transportation, commerce and communications, as well as convenient water supply and waste disposal. Development continued in these areas as people quickly forgot the problems caused by floods. Damages continued to rise in spite of efforts to control the flood occurences.

Today the Basin has a large flood control system but still experiences flood damages. Because of the historical development of the Basin, flood damages can be expected to continue into the future. Measures such as flood insurance and flood plain regulation, improved flood emergency preparedness and flood control projects will help to reduce future damages by limiting growth in flood plains. However, this process will be slow and require constant enforcement. Existing development will continue to suffer damages. The human suffering and environmental damage will also be expected to continue. Efforts will still be required to reduce the damages that can be measured in dollars as well as the possible loss of lives, the many regional business losses, the suffering of people that must be evacuated to live in temporary shelters, the erosion and siltation problems, and the many other losses that are part of a natural disaster.

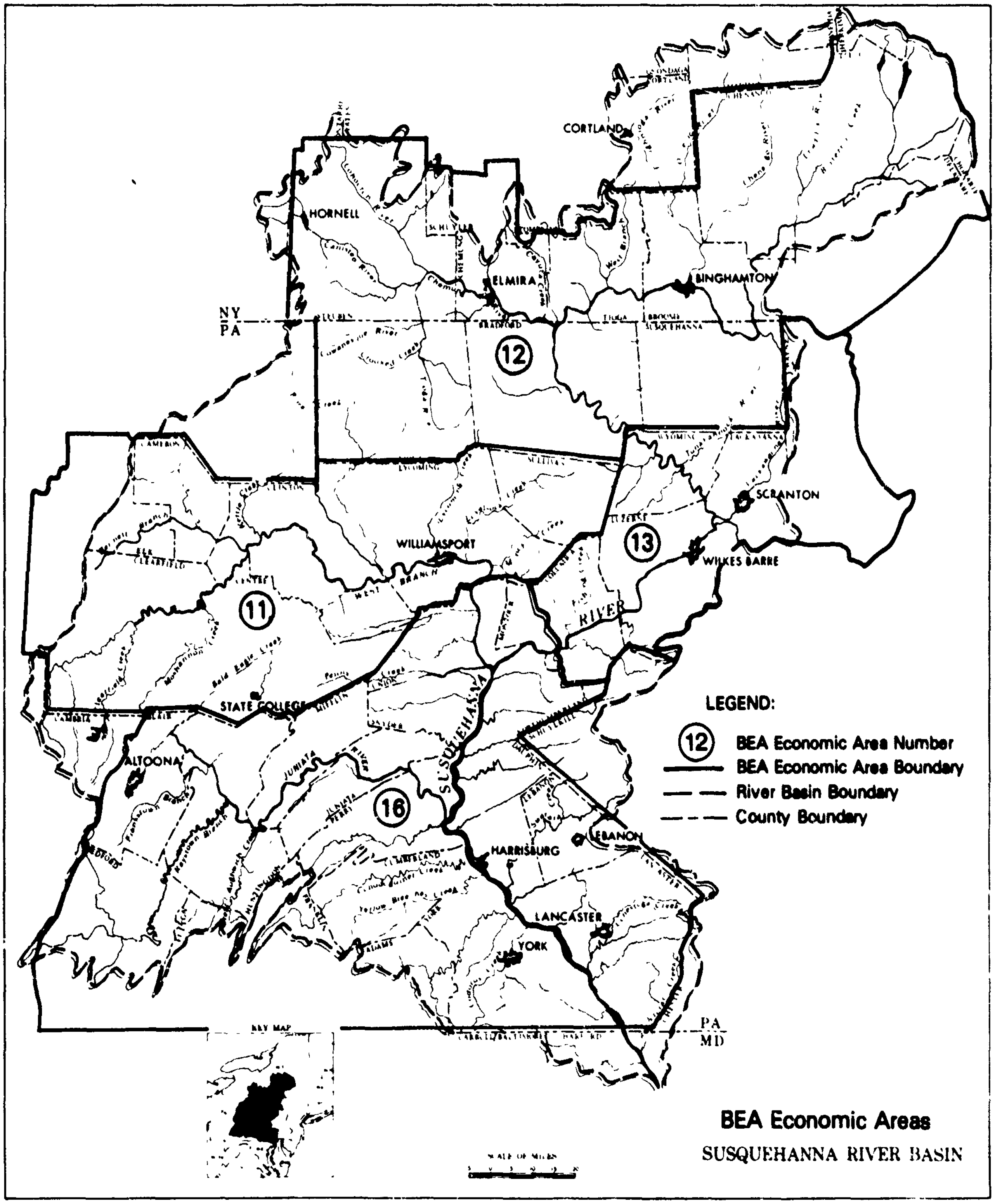
Basin Trends in Economic Development

The Susquehanna River Basin is forecast to experience continued population and economic growth. However, the amount of growth will vary among economic areas. The statistics show that there will be a gradual shift of population and economic activity within the Susquehanna River Basin.

Projected population growth and economic activity for the Susquehanna River Basin are taken from the 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E Population, Vol. 2 -- Bureau of Economic Analysis (BEA) Economic Areas and Vol. 5 -- Standard Metropolitan Statistical Areas, published by the U.S. Water Resources Council and dated April, 1974. The data has been organized and analyzed according to BEA economic areas; the boundaries of which were determined on the basis of population concentrations, retail and wholesale trade patterns, and labor market areas.

The Susquehanna River Basin is largely comprised of BEA economic areas 011, 012, 013, and 016. Figure 11 shows the geographic boundaries of the economic areas related to the basin boundaries.

The basin contains all or a major portion of eight SMSAs. These are Binghamton and Elmira SMSAs in New York state and the Scranton, Wilkes-Barre-Hazelton, Lancaster, Harrisburg, York and Altoona SMSAs in Pennsylvania. In 1970, approximately 40 percent of the basin's 3,621,733 residents lived in these urbanized areas. By 2020, 46 percent of the projected 4,848,100 residents are expected to live in SMSAs. An analysis of the spatial arrangement of most urban concentrations shows a band of urbanization along the main stem and/or major tributaries of the Susquehanna River. This is the result of the interrelationship between the river and the historical economic development of many of these urban areas.



BEA Economic Areas
SUSQUEHANNA RIVER BASIN

Figure 11

The size of the labor force is forecast to increase over the next fifty years primarily because of an increasing labor force participation rate. Total employment in the combined economic areas is predicted to expand from 1,430,378 in 1970 to 2,180,600 by 2020, an increase of 52 percent.

Manufacturing industries will remain the prime employer in the basin. However, the services and government sectors will increase their proportion of total basin employment opportunities. The proportion of employment in mining and agriculture is predicted to decline. Over the projection period, those manufacturing industries that will provide the majority of manufacturing job opportunities are: machinery (excluding electrical); electrical machinery and supplies; fabricated metals; transportation equipment; apparel; and food kindred products.

Per capita income levels are projected to increase both in absolute numbers and as a percentage of the national average per capita income. Per capita income changes differ among BEA economic areas in the basin. BEA area 016, the Harrisburg, Pennsylvania area, recorded the largest average per capita level with a per capita income of $3,266 in 1970 and an estimated per capita income of $12,700 by 2020. BEA area 011, the Williamsport, Pennsylvania area, recorded the lowest per capita income among the four economic areas that comprise the basin. In 1970, BEA area 011 had a per capita income of $2,868, and by 2020 is expected to record a per capita income of $12,400.

Market Area Power Supply and Demand

Table 11, presents past, present and projected future power requirements of the selected market area. Indicated future energy needs are estimated to increase to 508.2 billion kilowatt-hours in the year 2000 and to 1,157 billion kilowatt-hours in 2020. This includes pumping energy associated with existing and future pumped-storage hydroelectric projects located in the selected market area. The estimated peak demand of the market is expected to increase from some 30 million kilowatts in 1976 to 93.4 million in 2000 and to 208.2 million by 2020.

At the end of 1976, the Susquehanna River Basin market was supplied the total aggregate generating capability of 42.4 million kilowatts. Of this total, 9.5 million kilowatts, or about 22 percent, were located in the basin. Approximately 68.4 million kilowatts of additional capacity are planned or proposed in the market for the year 2000. This capacity conforms with projected construction to year 1995 and Water Resources Council Study projections to the year 2000. Of this additional capacity 18.7 million kilowatts, or about 27 percent, will be located in the Basin. The Susquehanna River Basin will, therefore, support a major share of the market's capability, rising gradually from 22 percent in 1976 to 26.2 percent, or 66 million kilowatts, in the year 2020.

Table 11 also addresses present and future market requirements to be provided from outside market to supply PSA 3, PSA 7, and the municipals and cooperatives being served by the Power Authority of the State of New York. (PASNY).

PROBLEMS AND NEEDS

Flood Damage Reduction

Flooding of property and threats to the life, health, and safety of basin residents is a significant problem in the study area. The history of flooding in the basin is as old as the basin's history of settlement. The level of development in the basin has steadily continued to grow despite the periodic occurrence of major floods. Tropical Storm Agnes caused $3.5 billion in damages in the basin in June 1972. It is estimated that the average annual flood damages from floods on the main stem Susquehanna and major tributaries total $50 million. Flooding clearly remains a

TABLE 11

POWER SUPPLY AND REQUIREMENTS OF MARKET AREA

	1976		1980		1990	
	Capability $KW \times 10^3$	Energy $KWH \times 10^6$	Capability $KW \times 10^3$	Energy $KWH \times 10^6$	Capability $KW \times 10^3$	Energy $KWH \times 10^6$
A. POWER REQUIREMENTS						
Peak Demand (Coincident)	30,054	163,364	38,500	201,300	60,700	321,800
Reserves	12,903	-	11,650	-	14,800	-
Pumping Energy	-	2,451	-	2,700	-	4,200
Total	42,957	165,815	50,150	204,000	75,500	326,000
B. POWER SUPPLY						
IC/GT	8,112	2,629	8,250	4,000	8,840	4,400
Fossil Steam	27,738	118,914	29,396	129,100	37,220	159,700
Nuclear Steam	4,361	26,196	9,306	56,400	24,020	144,100
Conventional Hydro	941	4,253	941	4,300	1,160	5,000
Pumped Storage	1,286	1,690	1,286	1,800	2,140	2,800
Sub-total	42,438	153,682	49,179	195,600	73,380	316,000
Net Receipts	519	12,133	971	8,400	2,120	1,000
Total	42,957	165,815	50,150	204,000	75,500	326,000
C. SUPPLY SITED IN BASIN						
IC/GT	441	134	441	200	450	250
Fossil Steam	4,460	28,485	4,460	26,000	6,642	37,700
Nuclear Steam	2,878	15,921	4,808	28,200	8,458	50,800
Conventional Hydro	852	4,081	852	3,800	1,070	4,700
Pumped Storage	880	1,069	880	1,100	880	1,100
Total	9,500	49,690	11,441	59,300	17,500	94,550
Percent of Market	22.1		22.1		23.4	

TABLE 11 (con't.)

POWER SUPPLY AND REQUIREMENTS
OF MARKET AREA

	2000		2010		2020	
	Capability $KW \times 10^3$	Energy $KWH \times 10^6$	Capability $KW \times 10^3$	Energy $KWH \times 10^6$	Capability $KW \times 10^3$	Energy $KWH \times 10^6$
A. POWER REQUIREMENTS						
Peak Demand	92,400	500,000	141,200	762,100	208,200	1,132,000
Reserves	20,600	-	29,800	-	43,800	-
Pumping Energy	-	8,200	-	14,900	-	25,000
Total	114,000	508,200	171,00	777,000	252,000	1,157,000
B. POWER SUPPLY						
IC/GT	9,500	5,000	10,300	6,500	12,000	8,500
Fossil Steam	50,700	210,000	71,700	283,000	100,700	398,000
Nuclear Steam	45,100	269,200	75,000	446,800	118,000	704,000
Conventional Hydro	1,300	5,500	1,300	5,500	1,300	5,500
Pumped Storage	4,200	5,500	8,000	10,000	13,000	17,000
Sub-Total	110,800	495,200	166,300	752,000	245,000	1,133,000
Net Receipts	3,200	13,000	4,700	18,000	7,000	24,000
Total	114,000	508,200	171,000	777,000	257,000	1,157,000
C. SUPPLY SITED IN BASIN						
IC/GT	600	300	800	500	1,000	800
Fossil Steam	10,000	41,000	14,800	58,000	22,800	90,000
Nuclear Steam	14,000	83,000	23,000	136,000	34,000	201,0000
Conventional Hydro	1,200	5,200	1,200	5,200	1,200	5,200
Pumped Storage	2,000	2,600	4,000	5,300	7,000	9,000
Total	27,800	132,100	43,800	205,000	66,000	306,000
Percent of Market	24.4		25.6		26.2	

serious problem in the basin. Recent flood history supports the claim of study area residents that flood control is one of the area's greatest needs in the long run.

Water Supply

Throughout history the presence of man and his improvements had depended heavily upon the availability of water. Water is needed for domestic and industrial use and for agriculture production. Trends indicate that the per-capita usage of water for domestic purposes will increase, as will the total demand, as population increases. Industrial use can also be expected to grow, however, technological advances may act to reduce the demand from individual industrial users. Agricultural usage is expected to increase as higher and higher yields are demanded from acreage under production.

Power

Mounting energy demand, sharply rising costs and changing social values have combined to place unusual stress on the electric power industry. The crisis has become painfully evident to the Nation at large in the form of natural gas and oil shortages and rapidly increasing costs for all forms of energy.

The Susquehanna River Basin is a major supplier of energy to the market area selected for this study. Twenty-two percent of the generating capacity in the market area is from sources within the basin and 30% of the energy generated in 1976 came from basin sources. Clearly the natural resource capability of the basin gives the area a comparative advantage in the production of hydroelectric energy. This is verified by the substantial exports of energy out of the basin. Realizing the problems and needs of power requirements within the nation and the resource capability of the Susquehanna River Basin; the feasibility of including hydroelectric power facilities in new multipurpose reservoir projects was considered as part of this study. Single purpose hydropower projects were not considered as they are not within the purview of this study.

Recreation

A comparison of the estimated basin water-oriented recreation demands with the projected supplies indicates that there will be an unsatisfied seasonal demand for each of the target years investigated. Three alternatives or combinations thereof were suggested by which the unsatisfied demands for water-oriented recreation within the basin may be reduced. The intensity of the recreation development on the existing public recreation area could be increased. More of the existing resource could be made accessable to the public and/or for more water bodies could be created and recreational facilities developed. With the development of feasible flood protection measure . which generally occur in developed urban areas, throughout the Susquehanna River Basin co scientious planning efforts can be directed to include or, at least, consider, the development of recreation facilities at these sites.

Improvements Desired

Local interests in the Susquehanna River Basin have made their desires known through statements and discussions at public meetings and other informal meetings within the basin and through personal and Congressional correspondence. In general, improvements are desired for flood damage reduction. Specific desires for improvements were expressed by many interests throughout the basin.

Virtually every community within the basin with a significant flood problem has expressed a desire for flood control improvements to protect their area from flood damages. Some areas of the basin have expressed desires for specific types of improvement. The major ones are as follows:

The West Branch Valley Flood Control Association, a citizens group located in the West Branch Susquehanna River area, has repeatedly expressed their desire for regional flood protection, namely reservoirs. Primarily this Association has expressed support of the potential dam at Keating as opposed to local flood protection projects such as the Lock Haven, Pennsylvania LFP.

The Coalition of Association for River Protection, a citizens group located in Wyoming Valley of Pennsylvania, has expressed their desire for regional protection in favor of local flood protection projects, more specifically, the Wyoming Valley Flood Protection Project. This organization favors dredging and clearing of the Susquehanna River in the vicinity of the Wyoming Valley as a means of providing regional flood protection.

The Susquehanna River Basin Commission and the Commonwealth of Pennsylvania, Department of Environmental Resources have expressed a desire for the evaluation of potential water supply storage as a multiple purpose feature of the major reservoirs at Keating, Pennsylvania. The water supply need which was identified by these interests is for the make-up of consumptive water uses during low flow periods.

Plan Formulation

The study's main goal, as expressed in the authorization, was to examine the feasibility of providing additional flood damage reduction in the Susquehanna River Basin. This goal led to the development of two broad, independent planning objectives for the study. The first and foremost was to contribute to the reduction of flood damages in the Basin while second was to contribute to the reduction of other Basin water resource related problems. However, this second objective was achievable under the study authority only if a multipurpose project or measure could be formulated to first meet the flood damage reduction objective and would then meet other associated water resource needs. These broad planning objectives served to guide the conduct of the study.

In keeping with the Basin-wide scope of the study, the plan formulation approach was designed to focus the available study resources on those problems and in those areas where the likelihood of success in solving those problems appeared the greatest.

Utilizing previous studies, current expressions of concern, and professional judgement, problem areas where identified and applicable resource management measures applied. Initial iterations in this approach identified the locations where solutions were not feasible, where additional problems could be addressed, and where the possibility of solutions existed. Further iterations narrowed down the possible feasible solutions until those areas were identified where more detailed studies appeared to be warranted.

FORMULATION AND EVALUATION CRITERIA

Formulation and evaluation of the alternatives for satisfying basin water resources needs were based on technical, economic and intangible criteria, including beneficial and detrimental effects on the basin's environment, and were conducted in accordance with the Water Resources Councils Principles and Standards for the Planning of Water and Land Related Resources. During the study major emphasis was placed on broad technical and economic criteria used to evaluate all alternatives and identify those which could possibly be implemented by the Federal Government.

Technical

The following important technical criteria were used in evaluating the alternative measures:

a. Potential projects warranting detailed consideration should be implementable in terms of reasonable use of the authorities and capabilities of involved levels of government and the resources of affected individuals.

b. Selected plans should be consistent with local and regional objectives and plans for resource utilization.

c. Evaluation of multiple purpose projects will be oriented toward providing the broadest range of water and related land management services for satisfying both planning problems and regional needs.

d. Structural flood damage prevention measures should provide the highest practical level of protection from damaging flooding compatible with other formulation criteria.

e. Selected plans for Federal participation in local flood damage prevention projects will include a flood plain management program by non-Federal project participants.

f. Plans developed must be engineeringly feasible.

g. Plans must reflect Corps of Engineers' design and construction standards.

Economic

Alternative measures were formulated initially to include all improvements and purposes which would satisfy the requirement that tangible benefits exceed project costs.

The benefits and costs are expressed in comparable terms to the fullest extent possible. All of the alternatives were based on October 1977 price level and 6-5/8 percent interest rate except where noted. Annual costs include interest, amortization, maintenance and operation, and major replacements.

Environmental and Other

The following environmental criteria and intangibles were considered in formulating a plan:

a. Avoidance, where possible, of detrimental social, environmental and economic impacts.

b. Betterment of public safety and social well-being, including the alleviation of possible loss of life.

c. The desires of the people directly affected by project implementation as well as involved local, state, and Federal agencies with general public acceptance and support being a primary consideration of the plan selection process.

MANAGEMENT MEASURES

Solutions to the many flooding problems in the Susquehanna River Basin can be classified into two general groups: structural and nonstructural. The structural measures are those which have historically been implemented by the Federal and/or State governments and include such engineering structures as levees, flood walls, reservoirs and channel modifications. Nonstructural solutions generally include measures which do not require extensive, if any, structural work. Some measures which fall into this category are relocation and floodproofing of individual structures, flood forecasting and warning, and regulation of flood plain use.

Table 12 presents a summary and comparison of possible solutions. A more detailed discussion of specific structural and nonstructural measures is presented in the following sections.

Structural

Structural measures are concerned with the building of engineered structures to preclude flood waters from entering flood vulnerable areas where they may cause damage. They include local flood protection works intended to protect only the flood vulnerable locality itself, and reservoirs, large and small, which provide flood protection to larger areas.

Local Flood Protection Projects: Local flood protection projects may include levees, floodwalls, and channel improvements, which either act as a barrier confining flood waters to a

TABLE 12

COMPARISON OF POSSIBLE ALTERNATIVES

Flood Damage Reduction Measure	Distinguishing Features	Approach to Flood Threat	Incidence of Cost	Administered By	Application to New Uses	Application to Existing Uses	Advantages	Disadvantages
Flood Warning and Evacuation	1 Warns flood plain residents and communities of flood threat 2 Permits advance evacuation and installation of emergency flood damage abatement measures	1 Adjusts to flood threat. 2 Organization should be ready for action during flood periods	1 Federal-State cooperation on flood warning 2. Local on evacuation and relief of flood victims	1 Federal and State on flood Warning National Weather Service River Forecast Center, Harrisburg, Pa 2 Local on evacuation and relief	Applies equally to new and existing uses.	Applies equally to new and existing uses.	1. Aids in adjustment to flood threat. 2. Useful in combination with other measures. 3. Prevents loss of life and aids in reduction of flood damages. 4. Makes everyone aware of flood problem.	1. Warning system must be adequately tested, operated, and maintained. 2. Flood plain occupants must be willing to take action. 3. Tends to encourage flood plain occupancy.
Flood Proofing	Individual building adjustments to reduce flood damage	Owner adjusts existing building to flood threat	Local/Federal	Local individual owner is responsible for action	Can be incorporated in design where structure would constitute a proper use of flood plain. Applies to structures subject to frequent low level and low velocity flooding	Not practical for residential structures. Can be applied to commerical and industrial buildings if they are structurally adequate. Applies to structures subject to low level, low velocity flooding	1. Permits occupancy of flood plain where there is a shortage of land. 2. Increases protection afforded by partial protection projects. 3. Enables buildings to be used during flood periods. 4. Can be applied to utilities which require the highest level of protection.	1. May discourage development of other flood protection measures. 2. Tends to induce a false sense of security 3. Tends to maintain existing uses in flood vulnerable areas. 4. When applied to structurally inadequate buildings, can increase flood damage
Zoning	1 Regulates location and type of uses 2 Protects floodway 3 Establishes flood protection elevations 4 A tool of comprehensive planning	Requires landowner to adjust use of land to flood threat	1 Landowner bears cost of adjustment 2 Local government bears cost of adoption of zoning regulations and administration	Local Zoning administrator issues permits, and Board of Adjustment issues variances and special exceptions	Regulates building, land alteration, and other features of land use	1 Limited application to existing uses. 2. Requires that existing uses be brought into conformity if abandoned, destroyed, or substantially altered	1. A tool of comprehensive planning to promote best use of lands in a community. 2. Can separate flood areas into zones depending upon flood hazard and apply varying standards to the zones. 3 Low cost Government power of implementation already in existence. 4 Can be put into effect immediately 5 Floods exceeding protection levels not as likely to result in catastrophic losses. 6 Can promote public acquisition of open space for parks, wildlife areas, etc	1. Limited application for preventing flood damages to existing uses. 2. May "take" private property if too restrictive 3. Does not regulate sale or transfer of lands, land subdivision, or detailed building design and materials. 4 Often weakened by variances and exceptions. 5 Has usually been unsuccessful when applied to high value existing uses. 6 Requires prior comprehensive planning 7 Can be politically difficult to implement

TABLE 12 (cont)

Flood Damage Reduction Measure	Distinguishing Features	Approach to Flood Threat	Incidence of Cost	Administered By	Application to New Uses	Application to Existing Uses	Advantages	Disadvantages
Sub-division Regulation	1 Applies to sale and division of land Does not in itself regulate use of land, therefore poor in protecting floodways. 2 Prevents victimization and fraud in sale of land to purchasers. 3 Protects floodways from encroachment by roads, buildings, and other structures 4 Insures municipal services are above flood levels or protected against flooding.	Requires developer to consider and make provision for flood threat	1 Developer bears cost of adjustment 2 Local government bears cost of adoption and regulation.	Local Planning Commission or Community Association	Wide potential in requiring disclosure of flood hazards, insuring lands will be suitable for intended purposes, and requiring installation of public facilities by developer.	None	1. Often applies extraterritorially for urbanizing areas, prohibiting the subdivision of lands subject to serious flooding unless hazards are overcome. 2. Not usually as vulnerable to judicial attack as zoning. 3. Protects unwary buyer. 4. Promotes most suitable use of land. 5. Passes cost of flood information collection to buyer 6. Low cost. Government power of implementation already in existence. 7. Can be put into effect immediately. 8. Can provide public open space acquisition for parks, etc.	1. Only indirectly limits uses; must be used in combination with zoning or master plan. 2. Difficult to protect floodways unless they are identified on maps. 3. Does not apply to structural design or materials. 4. Applies only to new sales and divisions. 5. Loopholes in ordinances can permit developers to escape enforcement.
Building Codes	1 Applies to design and materials 2 Does not in itself regulate land use, poor in protecting floodways 3 Insures safety of structures under flood conditions 4 Prevents reduction in property value and tax revenues by blighting.	Requires owner to adjust use to flood threat	1 Owner must bear cost of adjustment 2 Local government bears cost of adoption and administration	Local Building Inspector	Wide potential for establishing detailed construction methods.	Can require that existing uses be brought into conformity by flood proofing and by requiring use of materials less subject to flood damage when extensive modifications are made to a structure.	1. Applies to all new structures. Can require existing structures be brought into conformity. 2. Rarely attacked in courts. 3. Low cost. Government power of implementation already in existence. 4. Can be put into effect immediately.	1. Difficult to apply to existing uses. 2. Performance standards require expertise in enforcement. 3. Difficult to enforce.
Flood Insurance	1 Applies to all flood vulnerable structures 2 Local government must qualify before individual can buy insurance	1 Requires individual to bear part of cost 2 Encourages adequate regulation of flood plain use	1 Federal government pays, in part, for subsidized insurance 2 Owner pays for unsubsidized portion	Federal Flood Insurance Administrator, Department of Housing and Urban Development.	None	Coverage available on structures at subsidized rate if local community qualifies.	1. Spreads cost of flood losses. 2. Promotes regulation. 3. Encourages consideration of flood cost in private decision-making. 4. Provides economic relief to owner of flood vulnerable property.	1. Subsidized insurance may promote continued use at primarily public rather then private expense 2. May reduce effectiveness of flooding regulations. 3. May reduce effort to regulate existing use. 4. May discourage provision of protective measures.
Relocation	Removal of structures from the flood plain	Removes flood threat	1 Federal government pays major share 2 Also some local share	Combination of Federal, State, and Local.	None	Eliminates flood threat.	1 Entirely eliminates flood threat 2. May be used for selective removal of structures from flood plain. 3 Provides open space for parks recreation, etc	1 Large costs associated with relocating structures and municipal facilities. 2. Resistance of people to relocate residences, businesses, and industries.

TABLE 12 (cont)

Flood Damage Reduction Measure	Distinguishing Features	Approach to Flood Threat	Incidence of Cost	Administered By	Application to New Uses	Application to Existing Uses	Advantages	Disadvantages
Watershed Management	1. Reduces flood flows. 2. Enhances sound water and land conservation practices	Reduces flood heights by treating upstream watersheds.	1. Individual landowners pay major share 2. Local government has some responsibilities.	Cooperation of State, Local and county Soil and Water Conservation Districts.	1. Potential for reducing flood damages combined with sound conservation practices. 2. Can reduce flood heights while reclaiming gullied or eroded land.	Same as for "New Uses."	1. Generally small cost. 2. Attacks problems in headwaters. 3. Is usually consistent with broad community needs. 4. Combines flood control with sound conservation practices. 5. Requires little land per project and few relocations, thereby causing minor disruption of community. 6. Generally ecologically sound.	1. Only small potential for reducing flood losses. 2. For reducing flood damages, requires cooperation over entire watershed.
Local Flood Protection	Levees, floodwalls, channel modification, pumping stations, and appurtenant works to protect local flood vulnerable areas	Adjusts flood threat to land use needs.	1. Federal or state government pays major share 2. Local government has some responsibilities.	Combination of Federal, State and local.	1. Can reduce a wide range of flood losses. 2. Protects new land uses.	1. Can reduce a wide range of flood losses. 2. Protects existing land uses.	1. Reduces a wide range of flood losses. 2. Protects existing land uses. 3. Permits uses in areas where suitable land is scarce.	1. Generally large cost. 2. Requires a long time for planning and construction. 3. May not be consistent with community goals. 4. Environmental impact may be extensive. 5. Often induces a false sense of security. 6. Great flood may cause catastrophic losses from overtopping of levee system. 7. Tends to maintain existing uses in flood vulnerable area. 8. May encourage new uses in flood vulnerable area.
Small Upstream Reservoirs	1. Small reservoirs on tributary streams. 2. Multiple-purpose features can be incorporated such as recreation fish and wildlife conservation, etc	Is effective for small tributary flood problems but effects decrease markedly on main stem	Federal government pays major share 2. Local government has some responsibilities.	Combination of Federal, State, and local	Can be effective on small tributary but limited application on major streams.	Can be effective on small tributary but limited application on major streams.	1. Environmental impact generally less than for major reservoirs. 2. Multiple-purpose features can be incorporated, such as recreation, fish and wildlife conservation, and other conservation measures. 3. Local control of planning and management.	1. Applies only to minor floods. 2. Limited application for flood control. 3. For equivalent amount of flood protection, requires more land in a watershed than a major reservoir 4. Generally large cost. 5. Environmental impact can be extensive.
Major Reservoirs	1 Large reservoirs on main rivers and principal tributaries 2 Multiple-purpose features can be incorporated, such as water supply, recreation, fish and wildlife conservation, power, etc	Adjusts flood threat to land use needs	Federal government pays major share	Federal government has major responsibility	Has wide application for flood control	Has wide application for flood control	1 Reduces wide range of flood losses. 2. In regions where suitable land is scarce, can open up new areas for use. 3 Protects existing use. 4 May have significant recreational potential 5 Encourages large scale regional approach to flood problems.	1 Large cost. 2. Requires a long time for planning and construction 3. May not be consistent with regional goals. 4 Environmental impact is extensive. 5. Often induces a false sense of security. 6. Tends to maintain existing uses in flood vulnerable areas. 7 May encourage new uses in flood vulnerable areas. 8 May require larger scale relocations

floodway area or reduce flood stages by improving flow conditions in the channel and increasing the stream's carrying capacity. These projects are usually designed to provide a high degree of protection in a concentrated urban area.

Local flood protection projects are most commonly associated with urban areas where upstream reservoirs would provide limited protection. Local flood protection works are effective only in the elimination of flood damages from floods, equal to or less than that for which the protection works are designed. When a flood exceeds design level levees and floodwalls are overtopped and the damages which occur can be immense, since the entire protected area is usually inundated. Protection against the greatest flood possible is generally not feasible due to physical constraints and economic factors which limit the degree of protection that can be provided. To go beyond these limits often increases the cost of the protective works sharply, thereby making them economically unjustified and unacceptable to non-federal interests.

Reservoirs: The function of a flood control reservoir is to store a portion of the flood flow to reduce the flood peak downstream at the area where flood damages would occur.

Ideally, the reservoir is located immediately upstream of the area to be protected and stores most of the flood runoff upstream of the reservoir. Since the reservoir is located immediately upstream of the community to be protected, there is little additional inflow between the reservoir and the community, thereby offering substantial protection to the community.

As the distance between the reservoir and the community to be protected increases, the effectiveness of the reservoir decreases. The loss in effectiveness results from the lack of control over the local inflow between the reservoir and protected community.

Major Reservoirs: Major reservoirs in the Susquehanna River Basin have been constructed by the Corps of Engineers on major tributaries of the river. Generally, these reservoirs have a storage volume greater than 25,000 acre-feet and have regulated outlet works which provides control of the flow discharged from the reservoir.

A major reservoir, because of its large size, often offers opportunities for multiple-purpose development to include water supply, hydroelectric power production, water quality management, recreation, fish and wildlife conservation as well as flood control. Major reservoirs require large areas of land.

Small Upstream Reservoirs: Small upstream reservoirs are situated on small tributaries to the main stem of a river and are usually constructed by the Soil Conservation Service of the U. S. Department of Agriculture or the State. Reservoirs in upstream areas are effective in reducing flood damages on the streams on which they are located, but their effect on floods on major rivers is very limited. This results from several factors. A small upstream reservoir controls the runoff from only a small portion of the drainage area of the river, and consequently, a very large system of small upstream reservoirs would be required before appreciable effect on river flood flows could be realized. Also, a small upstream reservoir is not usually regulated by gates which can be helpful in controlling the peak flow at downstream damage centers. Hence, while an upstream reservoir may be highly effective in controlling a flood in the tributary stream on which it is located, the control over peak flows in the main river is usually limited. This characteristic limits the usefulness of small upstream reservoirs at major downstream damage centers, unless there is a large number of them. Small upstream reservoirs are valuable for local water supply, recreation, and fish and wildlife conservation, and flood control on a small drainage basin.

Nonstructural

Nonstructural measures are primarily of a management nature. They include relocation, flood proofing, flood forecasting and warning, regulation of flood plain use and watershed management.

Relocation: Relocation consists of the permanent removal of structures from a flood prone area to an area which is flood free. This generally involves purchasing the flood vulnerable land, demolishing or otherwise removing the structures, cleaning up the debris, and landscaping the area. New flood-free sites are provided for those facilities and institutions which are being relocated, together with necessary transportation facilities, utilities and landscaping. This is costly, making this method of flood damage reduction attractive only where the extent of development is small and the high flood risks cannot be reduced by other means.

Floodproofing: Floodproofing is a combination of structural changes and adjustments to properties subject to flooding primarily for the reduction or elimination of flood damages. Although it is more simply and economically applied to new construction, floodproofing is also applicable to existing facilities under limited conditions.

Floodproofing measures fall into three broad categories. First, there are permanent measures, such as constructing a new building so that its lowest occupied floor is raised above flood level or placing mechanical equipment on upper floors. Second, there are standby measures which are used only during a flood but which are made ready for use prior to the flood, such as special coverings for wall openings. Third, there are those emergency measures which are carried out during a flood or in anticipation of it. These would include the sandbagging of doors and window openings in order to prevent the entrance of flood waters and moving contents to a level higher than that projected for the flood.

Floodproofing does, however, have its limitations. While it can reduce interior damages substantially, exterior damages to individual buildings and the overall flooded area are not affected. Floodproofing can bring about a false sense of security and thus discourage the development of needed flood protection works or the timely evacuation of the flood plain. Also it can tend to increase the use of flood plains. Most important of all, if applied to a structurally inadequate building, it can result in more damage than would occur if the building were not floodproofed.

Flood Forecasting and Warning: Flood forecasting and warning is an integral part of any system of flood damage abatement works. Even though an area maybe protected by a system of local flood protection works or a system of upstream reservoirs, floodproofing, or a combination of these, there still remain some danger of flooding. To further reduce damages and especially to prevent loss of life, positive actions for evacuation of the flood plain areas are required should the anticipated flood condition warrant it. These actions must be carefully planned in advance so they may be effectively implemented. Effective evacuation depends upon an efficient flood warning system.

The successful organization and implementation of a flood warning and evacuation system depends primarily upon the work of the State and County Civil Defense program or a local entity. The River Forecast Center of the National Weather Service is responsible for the forecasting of river stage and making this information available to the local interests. The local entity is responsible for receiving this information, passing the warning on to the occupants of the flood plain, and initiating emergency evacuation plans, if necessary.

The River Forecast Center's forerunner, the Federal-State River Forecast Service, was established in 1937 and has improved its operations through the years that it is now possible for some areas in the Basin to receive flood warnings as much as 54 to 76 hours in advance. Figure 12 shows average warning times for many areas in the Basin. With adequate warning time, orderly and efficient evacuation is possible provided there has been advance planning for it and an organization for carrying it out is in readiness.

An important component of a flood warning and evacuation system is informing the residents of the flood plain of what procedures are necessary to be taken when they are notified that a potential flooding situation exists. It is also necessary to provide emergency shelter and provisions for the evacuated people.

Regulation of Flood Plain Use: Land use controls, most often known as "Flood plain regulations" do not attempt to reduce or eliminate flooding of the present damage potential, but are designed to mold the flood plain development in such a manner as to lessen the effects of future floods on future development. Flood plain regulation implies the adoption and use of legal tools by communities to control the type and extent of future development which will be permitted in the flood prone areas. For these controls to be effective, it is necessary that the public understand the general flood problem, the degree of risk, and the benefit of the methods that can be used to control use of the land. Regulation of the use of the flood plain requires that a map of the flood plain be developed outlining the areas which would be inundated by floods of varying magnitudes. With the flood plain delineated, action can be taken toward adopting regulations prescribing the best use of the flood plain.

These can include zoning, the regulation of new residential development as in subdivisions, and the use of building codes to require construction that will resist damage by floods. While not directly a part of flood plain regulation, the requirements for participation in the National Flood Insurance Program is associated with it. A discussion of the types of land use controls follows. Implementation of these measures is not a federal responsibility. Each locality has the ultimate responsibility for both implemention and enforcement.

Zoning: Zoning is the division of a community, whether it be a city, town, or county, into districts, or zones, and the application of regulations to guide development in each zone. One objective would be to regulate the type and construction of buildings - their size, their height, even their architectural design. Another would be concerned with the land itself. Land may be zoned for residential, industrial, or commercial use, for open space, recreation, or agriculture, or for any of a number of other uses.

Zoning can be an effective tool in flood plain regulation. The degree of flood hazard can be taken into account in determining the uses of various areas, or zones, in the flood plain. In addition to regulating land use, zoning regulations may be used to prevent the obstruction of floodways and to require the flood proofing of buildings. But it should be understood that successful zoning generally deals with future development. Attempts to require existing development to conform to zoning regulations, especially where extensive modifications would be required, have had only limited success. The National Flood Insurance Program requires, as a condition for participation, the zoning of flood hazard areas such that development within the 100 year flood plain is not allowed to increase.

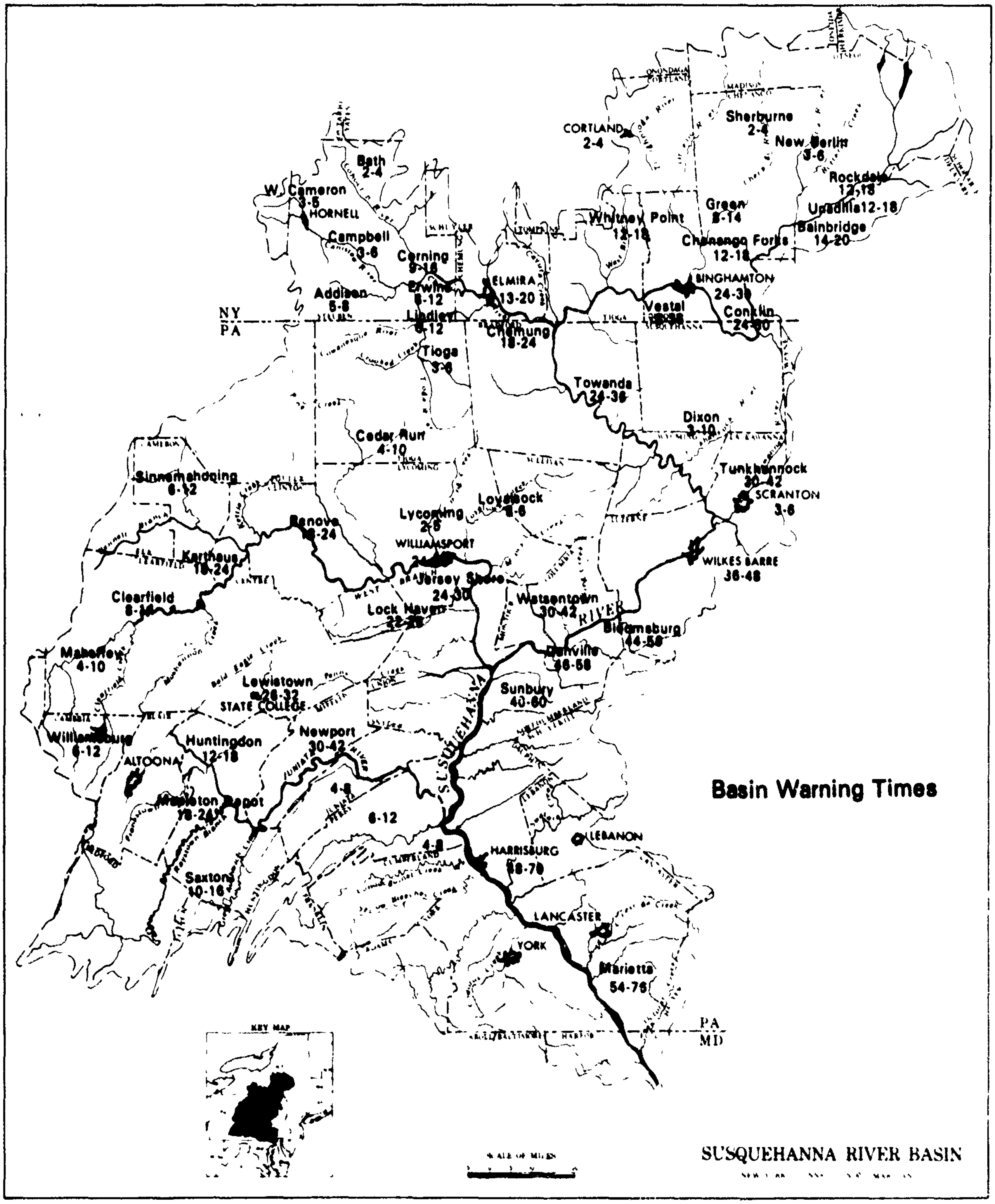

Basin Warning Times
SUSQUEHANNA RIVER BASIN
CORTLAND
2-4
Sherburne
2-4
New Berlin
3-6
Rockdale
12-18
Unadilla 12-18
Bainbridge
14-20
Bath
2-4
W. Cameron
3-5
HORNELL
Campbell
3-6
Corning
9-16
Erwins
6-12
Addison
5-8
Lindley
6-12
ELMIRA
13-20
Chemung
18-24
Whitney Point
12-18
Green
8-14
Chenango Forks
12-18
BINGHAMTON
24-30
Vestal
Conklin
24-30
NY
PA
Tioga
3-6
Towanda
24-36
Dixon
3-10
Cedar Run
4-10
Sinnemahoning
6-12
Tunkhannock
30-42
SCRANTON
3-6
Lycoming
2-6
Loyalsock
3-6
Renovo
18-24
WILLIAMSPORT
Jersey Shore
24-30
WILKES BARRE
36-48
Karthaus
18-24
Clearfield
Lock Haven
Watsontown
30-42
RIVER
Bloomsburg
44-56
Danville
46-56
Mahaffey
4-10
Lewistown
26-32
STATE COLLEGE
Sunbury
40-60
SUSQUEHANNA
Williamsburg
6-12
Huntingdon
12-18
ALTOONA
Newport
30-42
Mapleton Depot
18-24
4-8
6-12
4-8
HARRISBURG
LEBANON
Saxton
10-16
LANCASTER
YORK
Marietta
54-76
PA
MD
KEY MAP

Figure 12

Sub-division Regulation: The strict regulation of sub-division development can be an effective tool in limiting flood damages. Sub-division regulations cover street width, curbs and gutters, land elevation, surface water drainage, and such other matters as may be important to the welfare of the community. Among the last can be those which would contribute to a reduction in potential flood losses, such as delineating flood prone areas on sub-division maps, prohibiting the placement of fill that would restrict flow in a floodway, encouraging the construction of buildings on flood free sites with potential flood areas preserved as open space for parks, recreation areas, and wildlife refuges. Additionally sub-division regulations can specify that the new development could not result in any increase in the runoff of the area. This item is especially important in communities where a great deal of new development is expected.

Building Codes: Building codes, which set standards for building construction in order to protect the health and safety of the public, can be used effectively as a means of reducing flood damage. Floodproofing, in so far as safety is concerned, can be required for apartment houses, hotels, motels, stores, places of amusement, and such other places as may be used by the general public. It should be understood, however, that while the application of building codes can go a long way toward insuring the structural stability of a building and can aid in preventing the flooding of building interiors, building codes have no effect on grounds and exterior supporting facilities.

Flood Insurance: Flood insurance does not reduce flood damages and is not properly a nonstructural measure for flood plain management. It does provide monetary compensation for flood damages which have been suffered. Some discussion of flood insurance is of value in any discussion of flood plain management. Furthermore, the National Flood Insurance Program, which was established by the Housing and Urban Development Act of 1968, requires that participating State and local governments adopt and enforce land use regulations which restrict future development in flood vulnerable areas. The program, which is administered by the Federal Emergency Management Agency (FEMA) is designed to meet a need in flood zones which the private insurance industry would be unable to meet without assistance.

The Federal insurance program does not require complete prevention of construction in a flood vulnerable area. Rather, the program provides economic relief for existing structures which are vulnerable to flood damage but only on the condition that the community take steps to insure that new development will be above the 100-year flood level. This is the flood which has a one percent chance of occuring in any given year or a probability of being equaled or exceeded on an average of once in any 100 year period. The area which would be inundated by the 100 year flood is outlined by FEMA. By September 30, 1977, all identified flood prone communities must have joined either the regular or emergency program or Federal funds for various programs would be restricted.

Watershed Management: The condition of the land in a watershed and the use which is made of it have an influence on the amount of rainfall which runs off into streams and rivers. By managing the land, a reduction can be made in this runoff, and floods can be reduced. The aim is to improve the ability of the land to hold water, and this can be accomplished in several ways: forestry management; terracing; contour plowing; strip cropping; planting cover crops; and building farm ponds. All these measures induce percolation into the soil and reduce erosion and sedimentation, which reduce the capacity of channels and reservoirs and impede the flow of water into streams.

Watershed management makes good sense ecologically. It produces tangible benefits for both the landowner and those who live and work downstream. It does, however, have limitations, and these should not be overlooked. Watershed management is most effective on small streams where the time between rainfall and peak runoff is not more than two to three hours. On major

rivers, where flood waters keep rising and volumes keep increasing over several days or more, it is not as significant.

The application of watershed management measures is largely the responsibility of individual landowners, with technical assistance provided through the County Soil and Water Conservation Districts. Some financial assistance for such efforts is available, but most of the investment must be borne privately.

ALTERNATIVES CONSIDERED

There are many solutions to flood problems which have to be considered in order to identify the most appropriate plan of protection for flood prone locations. The possible solution as identified range from large projects such as multiple purpose reservoirs to individual efforts such as temporary evacuation of flood threatened areas. The methods available to either reduce or eliminate flooding in the flood plain involve both structural and nonstructural flood control measures.

In view of the fact that approximately 300 communities along the main stem of the Susquehanna River and its major tributaries, and approximately 800 communities along the smaller streams in the basin are subject to flooding, an in depth analysis of each community is not practicable. In addition, only the measures which could be implemented by the Federal government, primarily under existing flood control authorities governing the Corps of Engineers and the Soil Conservation Service were addressed. Implementation of such measures as flood insurance and flood plain management is the responsibility of non-Federal entities and were not evaluated quantitatively as part of this study.

The measures which have been addressed and are presented in subsequent sections include structural local flood protection measures such as levees, floodwalls, channel modifications, major reservoirs, small upstream reservoirs, nonstructural local flood protection measures such as the raising, flood proofing, and relocation of structures to flood free sites, and flood forecasting and warning.

The analyses of each of the flood control measures involved varying degrees of detail and evaluations, with more detailed study performed for those locations having the most potential for flood control project feasibility.

Major Reservoirs

Of the various methods of flood control available, the one that is probably the most obvious and has historically received much attention is reservoirs. The function of a flood control reservoir is to store a portion of the flood flow to minimize the flood peak downstream at the area to be protected. The objective of the study of potential reservoirs was to identify those which would satisfy the planning objectives of the study and meet the formulation and evaluation criteria. Potential projects were screened numerous times. Since satisfying identified flood control needs was the primary objective of this study, the first screening was based solely on the capability of the site to meet this need. Potential projects having good flood damage reduction capabilities and which showed a potential for economic feasibility were studied for multiple purpose features. Preliminary evaluations of hydropower and recreation were conducted independently and concurrently for these sites and the screening process continued based on these results. Sites retained were then studied to determine their potential for satisfying identified water supply needs and a final screening was then made. The subsequent paragraphs present a general description of the evaluations made and the results.

Site Selection, Design and Cost: Previous studies of the Susquehanna River Basin have produced a great deal of data concerning potential major reservoir sites. As part of the Susquehanna River Basin Study, completed in 1970, a complete inventory of potential reservoir sites was made which served as a base for this study. A large portion of these data, specifically the site selection and preliminary design and quantity estimates. were used as the foundation of this study effort. Changed conditions made much of the hydraulic and economic data developed on these sites obsolete and thus, when needed, new information was derived.

Design and cost estimates were made for either earth or concrete dams, or where there was doubt as to which would be more feasible, estimates were made for both types of structures. This information was usually prepared for three levels of development in order to construct a storage versus cost curve. The maximum development at each site provided usable storage equal to 14.5 inches of runoff over the upstream drainage area or at a lower capacity where topography imposed limiting conditions.

The results of these investigations, which included all the engineering and judgment aspects of preliminary site analyses, were then processed by data processing equipment. The output consisted of a quantity and cost estimate for each type of dam at each level of development considered. The following is a description of the basic design and estimating assumptions and procedures used in preparing preliminary cost estimates.

Real Estate: Real estate acquisition was based on the purchase in fee of all lands up to the maximum flood pool elevation, any additional lands lying within 300 feet horizontally from the crest elevation of an ungated spillway or the top of gate elevation for a gated spillway, and the land required for the dam and appurtenances, and for highway and railroad relocations.

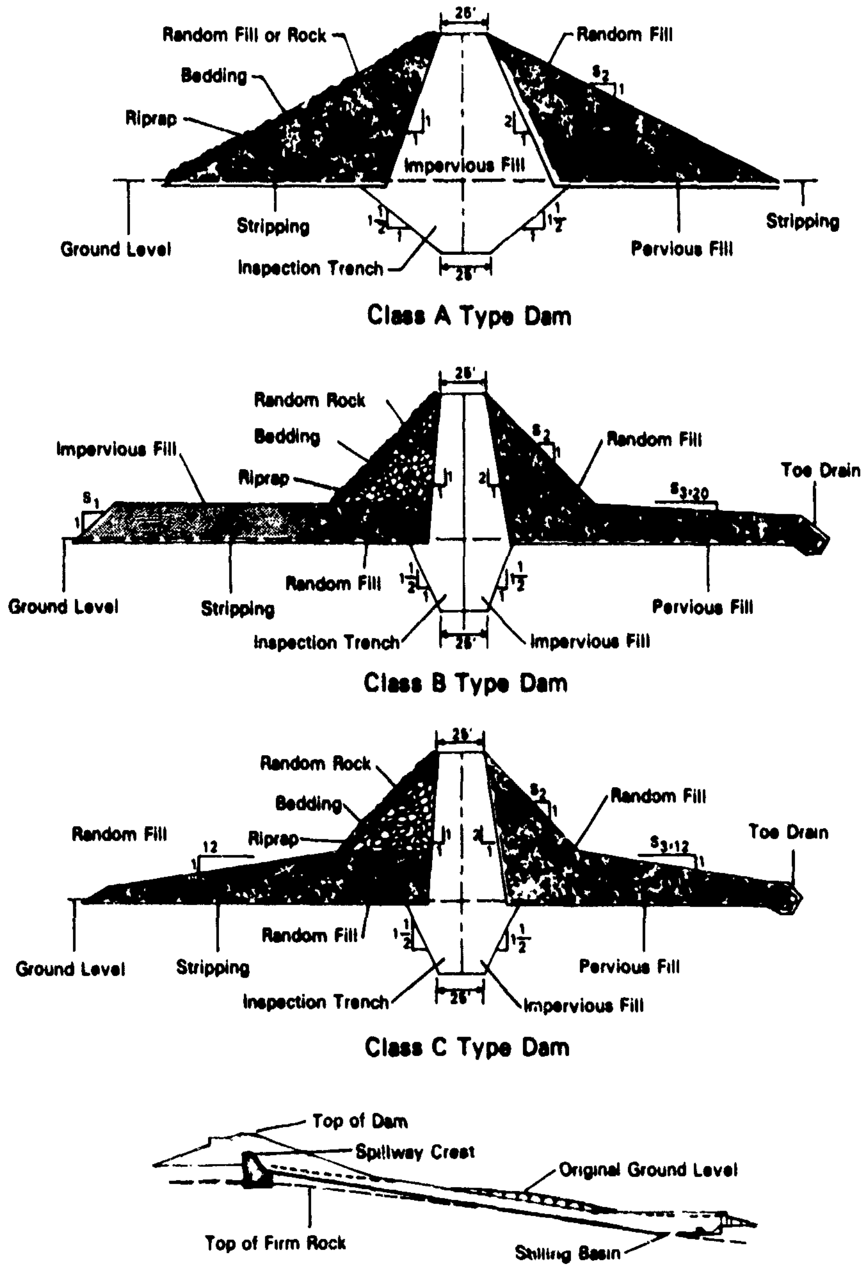
Generalized unit costs for acquisition of lands and improvements were developed. These generalized prices were based on recent sales data in the respective county assessors office and recent Corps of Engineers acquisition experience in the basin.

Relocations: Highway, railroad, gas pipeline and high voltage transmission line relocations were based on plans to provide essentially the same service to remaining areas as would exist without reservoir construction. Cemetary relocations were based on reinternment at an acceptable location of all remains affected by the reservoir. Local utility relocations were based on reestablishing the same service to remaining areas as would exist without reservoir construction.

Generalized per mile unit costs for the relocation of highways were based on cost obtained from the State Highway Departments involved and from the Federal Highway Administration, and on recent Corps of Engineers construction experience in the Basin. These costs include an allowance for bridges and drainage structures.

Dam and Appurtenances: Preliminary designs for earth and rock embankment dams and gravity concrete dams were based on recent Corps of Engineers' structural and hydraulic design criteria. The generalized sections upon which construction quantities for earth embankment dams, outlet works, and spillways were based are shown on Figure 13. Construction quantities for concrete gravity dams were based on the generalized configuration shown on Figure 14.

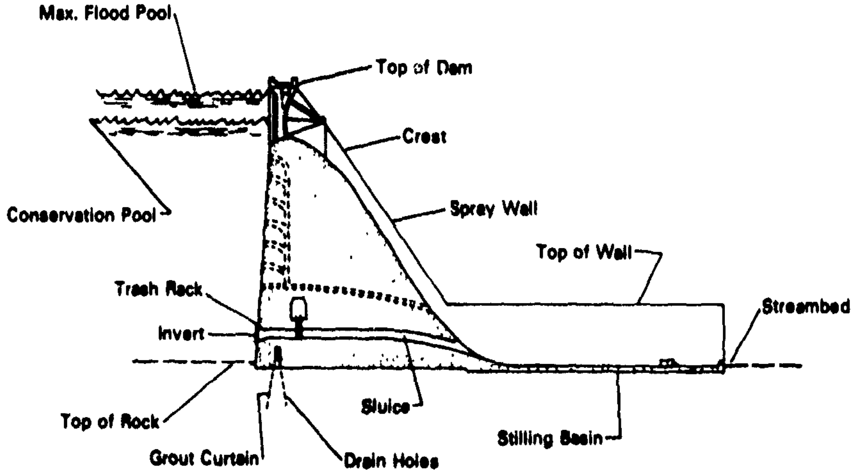
Typical Sections for Earth Dams



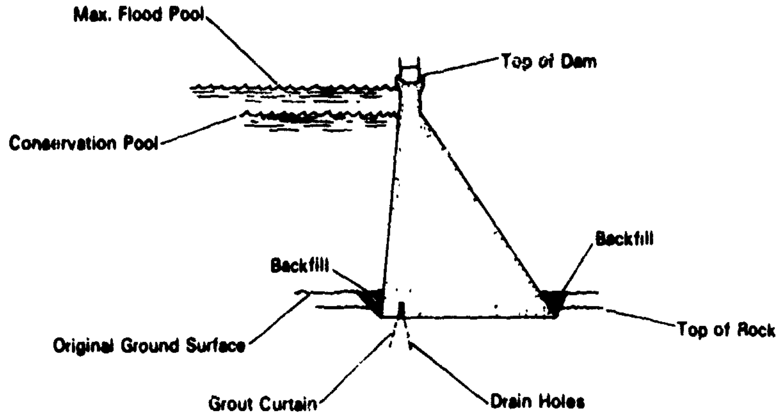
Profile on Centerline Line of Spillway

Figure 13

Concrete Gravity Dams



Typical Over Flow Section



Typical Non-Overflow Section

Figure 14

All spillways were designed to pass the estimated Probable Maximum Flood (PMF) with a freeboard of 5 feet. Spillway chutes and stilling basins were generally sized to contain the Standard Project Flood (SPF) except at such locations where stability of a dam would be endangered by overflow while passing the PMF. In such cases, chutes and stilling basin were designed to contain the PMF.

Outlet works for earth or rock embankment dams were sized to provide for diversion of a 10-year construction season flood (approximated as the 8-year annual flood) with cofferdam heights not exceeding 60 feet. For sites with drainage areas less than 60 square miles, the 4-year annual flood was used for sizing outlet works for diversion. For large structures, gates were sized to allow the full capacity of the outlet works to be usable during operation; however, for sites with less than 60 square miles drainage area, the operational capability of the outlet works was limited to discharges of the mean annual flood. Flood peaks for the 8-year, 4-year, and mean annual floods were estimated from generalized peak flow frequency studies. Quantity computations were made for a range of sizes of the appurtenances for earth and concrete dams. For an earth dam these included: multiple level low flow release systems, outlet works conduits and tunnels, outlet works stilling basins, outlet works towers and intake control structures, outlet works control gates, spillway chute walls and slabs, spillway chute stilling basins, and spillway crest gates.

For a concrete dam they included: spillway stilling basins, spillway training walls, spillway piers, spillway crest gates, sluice gates, control towers, and multiple level low flow release systems.

Access Road: Access to each dam site is required for normal operation and maintenance activities. Access road design was based on the requirements of a two lane paved secondary highway. The access road was laid out on a quadrangle sheet, categorized as to terrain classification, and the length measured. The per mile construction costs are the same as those used for highway relocations.

Permanent Operating Equipment: A permanent damtender's house is required at each reservoir site where operating equipment is included for flood control operations or low flow augmentation. In addition, garages for mobile maintenance equipment and maintenance workshops are required. Where appropriate, allowances were made for the operating equipment. For drainage areas less than 60 square miles, where operating equipment was not included in the design, no cost was included for this item.

Unit Prices: Unit prices used in estimating the cost of dam and reservoir projects were based on the cost of similar projects in the Susquehanna River Basin. Contingency costs were estimated as 25 percent of the first cost of the project.

This Corps of Engineers' study identified 87 reservoir sites for individual consideration as one means of meeting many of the Basin's water associated needs. The sites were scattered throughout the Basin with 20 located in New York and 67 in Pennsylvania. There were none in Maryland as no in-Basin needs appear to require reservoir storage.

Flood Control: A reservoir systems analysis was conducted. In here twenty-two potential reservoir sites, listed in Table 13 and shown on Figure 15, were identified for inclusion in the analysis. The selection of the sites was accomplished through a review of the 1966 Storage-Potential Report to determine the best sites in terms of flood control potential. A further refinement of the site selections was made and this is reflected in the information listed in Table 13.

The principal objective of the systems analysis was to identify the most effective and economically efficient system of new major reservoirs for flood control. The 22 reservoir sites included in the analysis were evaluated only for flood control storage and operation to determine flood damage reduction benefits. The results of the systems analysis provided a relative ranking of the reservoirs by their flood control potential and economic effectiveness. These projects having the most potential were identified for further study. The further study included evaluation of multi-purpose project features, refinement of economic and engineering data, and interrelationship with other considered flood control measures.

The basic analytical tool used for the systems analysis was a computer simulation model (HEC-5C) developed by the Corps of Engineers' Hydrologic Engineering Center, for reservoir flood control operation in the Susquehanna River Basin. The primary output of the model is the flood discharge reductions at selected key flood damage centers due to the operation of existing and/or proposed upstream reservoirs. The discharge reductions were then used, in conjunction with stage-discharge, stage-damage, and discharge-frequency relationships, to estimate the flood control benefits attributable to the reservoir(s) at the damage centers. The estimated average annual benefits could then be totaled and compared to the associated annual cost for the reservoir or systems of reservoirs and benefits to cost ratios formulated. It was recognized that the results of the reservoir systems analysis, particularly the economic findings, were subject to change as more current and refined data becomes available, but the relative ranking of the potential projects were still valid.

The systems analysis was performed in three distinct phases. During each phase various combinations of three basic evaluation techniques, which used output from the computer model, were utilized. The techniques are the first-added, last-added, and system effect analyses. The first-added analysis involves a comparison of the effectiveness of the existing reservoir system with that of the existing system plus one potential reservoir. For the last-added analysis, measures of reservoir effectiveness are determined and compared for the system of existing and all potential reservoirs less one potential reservoir. The comparisons made during the first-added and last-added analyses identified the change in economic and hydrologic parameters which are attributable to the single potential reservoir being considered. The system effect analysis includes a comparison of the results for a system of existing and potential reservoirs versus the sum of a first-added analyses for each of the potential reservoirs in the system, thus revealing any interdependence of the reservoirs.

Phase I of the reservoir systems analysis, "Initial Reservoir Screening," was the initial analysis of the 22 potential reservoirs listed in Table 13 to determine which ones were the most promising projects and warrant further study. Thirteen reservoirs identified in Table 14 were selected primarily on the basis of the first-added analysis for study during Phase II along with 12 reservoir systems consisting of various combinations of the 13 individual reservoirs.

Phase II of the study, "Analysis of Selected Reservoirs and Systems," involved a refined analysis of the 13 reservoirs and a thorough investigation of the 12 reservoir systems identified in the Phase I study. For Phase II, all three evaluation techniques were used. The results of the Phase II study were a reaffirmation of the selection of the 13 reservoirs with the most potential and an identification of nine reservoir systems that showed a good system performance relative to the sum of the individual reservoir effects.

Phase III of the analysis, "Detailed Reservoir Analysis and Reservoir System Evaluation," was a still more refined analysis of the 13 selected reservoirs. Table 14 presents the benefit-cost ratios computed as part of the systems analysis. Five reservoirs, Keating, Sinnemahoning, Genegantslet, Copes Corner, and East Guilford were identified as those dams with the highest flood control potential. Four systems, including combinations of these five reservoirs, were also analyzed but dropped since no increases in economic efficiency were apparent. It must be

TABLE 13

POTENTIAL MAJOR RESERVOIR SITES SELECTED FOR SYSTEMS ANALYSIS

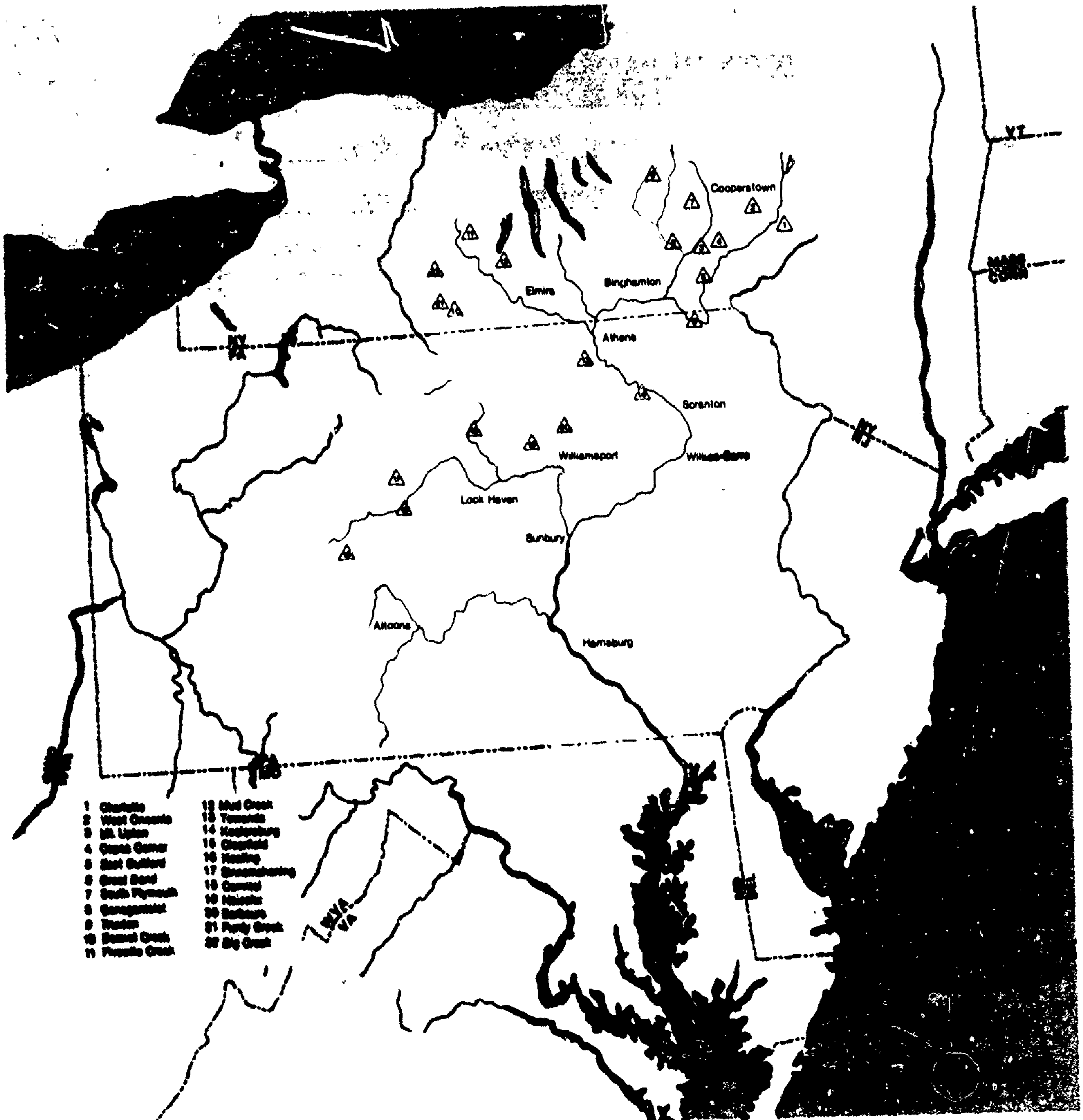
Site	Primary Reasons for Selection				
	1970 Study Results		Other		
	Early Action 1/	Frame-Work 2/	Autho-rized 3/	Demonstra-ted Need 4/	Request 5/
Charlotte	X		X		
West Oneonta			X		
Mt. Upton				X	
Copes Corner			X		
East Guilford		X			
Great Bend				X	
South Plymouth	X		X		
Genegantslet			X		
Truxton	X				
Bennet Creek				X	
Fivemile Creek	X				
Mud Creek	X				
Towanda				X	
Keelersburg				X	
Clearfield				X	
Keating				X	
Sinnemahoning				X	
Cammal				X	
Haleeka				X	
Barbours				X	
Purdy Creek					X
Big Creek					X

1/ Included in the Early Action Plan of the comprehensive Susquehanna River Basin Study.

2/ Included in the Framework Plan of the Comprehensive Susquehanna River Basin Study.

3/ Authorized, but never constructed, projects.

4/ Need for additional flood control in the vicinity of these sites demonstrated by the June 1972 flood experience and/or initially favorable results during the 1970 study.



VT
MASS
CONN
Cooperstown
Binghamton
Elmira
Athens
Scranton
Williamsport
Wilkes-Barre
Lock Haven
Sunbury
Altoona
Harrisburg
NY
PA
MD
W.VA
VA

Figure 15

TABLE 14

INITIAL SCREENING

RESERVOIR SYSTEMS ANALYSIS

Reservoir Name 1/	Benefit-Cost Ratios 2/
Charlotte*	0.18
West Oneonta	0.25
Mount Upton	0.42
Copes Corner	0.45
East Guilford	0.57
Great Bend	0.35
South Plymouth*	0.32
Truxton*	0.34
Genegantslet	0.49
Bennett Creek*	0.22
Purdy Creek	0.33
Fivemile Creek*	0.24
Mud Creek	0.31
Big Creek*	0.35
Towanda	0.30
Keelersburg	0.23
Clearfield*	0.42
Keating	0.57
Sinnemahoning	0.41
Cammal	0.28
Haleeka*	0.11
Barbours*	0.06

1/ See Figure 20 for project location.
2/ Flood control benefit only with project as "first added."

*Project carried through Phase I studies only. Remaining projects showed some flood control potential and were retained for Phases II and III.

recognized that the reservoir systems analysis addressed only flood control aspects of the potential projects. The analysis served as a good measure of flood control effectiveness of potential reservoirs and was the basis for identifying where additional study was warranted. A more detailed discussion of the system analysis study may be found in the February 1976 report titled "Susquehanna River Basin Flood Control Review Study-Reservoir Systems Analysis."

Recreation: The major reservoir recreation analysis provided an appraisal of the potential for recreational development at each of the 13 dam and lake sites selected in Phase II of the reservoir systems analysis. The recreation analysis included an examination of the potential demands for various types of outdoor recreation activities including camping, swimming, boating, and picnicking at each of the 13 prospective projects and an examination of the potential costs and benefits of recreation areas and facilities.

The analysis did not address the following:

1. Loss of existing recreation areas and facilities and the use associated with them due to the construction of these projects;

2. Types of recreation to be provided at the project other than camping, swimming, boating, and picnicking;

3. The total cost of public use of each project;

4. The allocated costs for increased reservoir storage; and

5. Compatability of recreation with project purposes other than flood control. This could be particularly critical in the case of hydroelectric power development, for the operating characteristics could significantly reduce recreation benefits.

Because the analysis was only a preliminary evaluation of the 13 projects in terms of recreation development, it is appropriate that the items listed above be addressed in more detail if further studies are conducted. It was felt that the information and data used in the analysis were sufficient to provide general estimations of the costs, benefits, visitation and other factors associated with the recreational development at the various projects.

The reservoir recreation analysis was performed on the basis of the following assumptions:

1. Current population and economic growth rates will continue through the 100 year life of the project;

2. All Federal water development projects now in the advanced engineering and design phase will be constructed and fully operational by the year 1980; and

3. All presently known plans for development of non-urban water oriented outdoor recreation facilities by state and local governments will be fully implemented by the year 1980.

The procedure used for forecasting the initial recreation demand at prospective projects is described in the Corps of Engineers Technical Report No. 2, Estimating Initial Reservoir Recreation Use. The recreation use prediction method used compares the proposed project to projects already in operation as a means to predict possible recreation use trends, extent of facilities development, and the effects of competing water-oriented recreation areas. The

recreation use as predicted from the above procedure provides the initial year's total recreation use in recreation days. The recreation use for the 100 year life of the project was forecast by multiplying the initial use by the expected percentage of population increase for ten year increments for the counties in the day use market area. The method for deriving the average annual recreation benefits and costs, including initial investment, operation and maintenance, and future major replacement is described in the Corps of Engineers Technical report No. 5 entitled the Derivation of Average Annual Recreation Benefits, Costs, and Alternative Cost in Multiple Purpose Project Analysis Including Future Recreation Increments: Survey Scope Investigation.

Cost estimates for providing recreation facilities were obtained from Outdoor Recreation A Legacy for America -- Outdoor Recreation Facility Cost Estimates, published in 1974 by the Bureau of Outdoor Recreation (BOR). The construction costs were updated using construction costs indexes (ENR). The average annual recreation costs include the costs of construction, operation, development of initial and future facilities, major replacement, and the costs of access roads. In addition to economic, other results of the analysis include the following information for each project:

1. Adaptability of each site for recreational development.
2. Aesthetic conditions of each lake site.
3. Existing access to each lake site and its impact upon recreation development.
4. Conclusions as to whether demand can or cannot be met by recreation development at each lake site.
5. Limitations to recreational development.
6. Competing water-oriented outdoor recreation areas.

The annual costs and benefits for including recreation as one of the multi-purposes for the 13 prospective reservoir projects are included in Table 15.

Hydroelectric Power: The evaluation of hydroelectric power development for six of the thirteen major reservoirs was accomplished through a contract with an engineering consultant firm. The six sites were selected mainly on the basis of topographic considerations which indicated a reasonable possibility of incorporating sizable hydroelectric power facilities at these sites. The conventional hydropower potential for each site was evaluated for three different reservoir storage allocations to provide information sufficient for plan formulation studies. Another major consideration being addressed was the need for a downstream reregulating dam if turbine discharges were found to be excessive for either environmental or engineering reasons. Where reregulating dams were required, consideration was given to the installation of reversible pump-turbines and development of pump-back capability at the site. A qualitative evaluation of the potential of off-reservoir pumped storage was also made at all sites based on topographic features. Included in the reservoir sites which were evaluated for hydropower were Keating, Sinnemahoning, Cammal, Great Bend, East Guilford, and Keelersburg. Locations of these sites were shown on Figure 15.

Conventional Hydropower: Conventional hydropower developments produce electricity by converting the energy of natural or regulated streamflows falling through the head created by the dam. The difference in elevation between the lake surface and the turbines represents the amount of potential energy available to generate electricity.

TABLE 15
RECREATION COSTS AND BENEFITS

(October 1977 Price Level)

Reservoir	Annual Benefits ($1000)	Annual Costs ($1000)
West Oneonta	$970	$510
Mount Upton	1,430	500
Copes Corner	660	220
East Guilford	650	180
Genegantslet	680	240
Purdy Creek	160	70
Mud Creek	500	140
Towanda	1,490	560
Keelersburg	4,030	1,490
Keating	430	170
Sinnemahoning	370	260
Cammal	150	60
Great Bend	5,000	1,740

For each of the reservoirs, routing studies were made and available flows computed and used to determine base power potentials. Turbine types and sizes were selected and major elements of the powerhouse established. With the basic information, a power plant location and orientation was analyzed and studied for various conditions. A preliminary power plant arrangement with power related facilities, which was considered feasible as well as practical, was selected and a construction cost estimate was made.

Determining the river flow characteristics and computing water potential for power for each of the reservoir sites and storages involved analyzing hydrologic records and preparing differential mass diagrams. The differential mass diagram is a graphical representation of the cumulative mass difference in acre-feet compared to the long term average plotted against time. Its primary purpose is to determine the available minimum flow for power generation for a specified storage volume during a critical low flow period. For each storage allocation, there is a critical period that yields the least available flow for that particular assumed storage. The critical drought periods were determined using the differential mass diagram.

Having established the water potential for power generation, studies were made to determine the various sizes of a conventional hydropower plant, to analyze the specific effects that power releases might have on the downstream channel, and to determine the requirement for a downstream reregulation dam.

For comparison purposes, it was decided to provide an analysis based upon several different plant factors which established a range of capacity and energy values which would likely be compatible with power systems in the power market area. Plant factor is a term used to denote the operational characteristics of a power producing facility. It is defined as the ratio of the average demand on a plant during a specified period of time to the total rated capacity of the plant, expressed as a percent. Plant factors of 5, 10, and 15 percent were selected to best represent the demands of the geographical area. Utilizing the three different storage allocations with the varying plant factors, capacity available in kilowatts and potential annual energy in kilowatt hours were calculated as follows:

$$\text{Capacity} = \frac{Q \times \text{firm head} \times e}{11.8}$$

$$\text{Energy} = \frac{Q \times \text{average head} \times e \times PF \times \text{hrs/year}}{11.8}$$

Where: Q = flow in cfs

e = efficiency

PF = plant factor

The selection of power plant facilities was limited to units that would meet the criteria established for power pool allocations. Schemes were developed and selected for each of the storage allocations. Specific construction costs estimates were made for all the hydropower facilities including: the powerhouse, turbines, governors, main power system and equipment, switchyard, power tunnel and penstock, transmission facilities, access roads, and reregulation dam. Operation and maintenance were also estimated for each of the alternatives.

In the operation of the reservoirs for power generation, it was assumed that the full reservoir storage allocation was used. If the turbine discharges were excessive for any of the selected alternatives, construction of the reregulation dam was to be considered to dampen the effects of destructive surges and discharges to the downstream channel. Criteria to determine the elevation of the top of the spillway crest of the reregulation dam was established so that each storage allocation and plant factor, the size of the reregulation dam would be sufficient to provide storage and head to maintain constant releases through the outlet works at the dam for all hours of each weekday, and to maintain constant releases at or slightly above the minimum flow requirement.

For each of the reservoirs investigated for hydropower, the optimum storage allocation and plant factor was selected by optimizing the power produced and the benefit to cost ratios (B/C). The pertinent data for each of those alternatives is shown on Table 16.

The hydropower benefits for each of the alternatives are measured in terms of the costs of achieving the same power production by the most likely alternative means that would exist in the absence of the project. The power values or estimate of the cost of the cheapest alternative means of power production for each site and plant factor have been determined by the Federal Energy Regulatory Commission. The resulting hydropower benefits for the optimum alternative for each alternative are listed in Table 17.

Conventional Hydroelectric Power With Pumpback Capabilities: The conventional hydroelectric power with pumpback capabilities would consist of conventional power facilities in the main dam (forebay) and a downstream reregulating dam which would control discharges and also provide a lower pool (afterbay) for reversible pump-turbines to be included in the facilities at the main dam. Power to meet peak needs would be generated by discharging water from the main reservoir (forebay) through the turbines located in the main dam. The reregulating dam would then be used to store a portion of the discharge until available off-peak power was used to pump back a portion of the water from the afterbay (into the forebay).

For each of the reservoir alternatives which required a reregulating dam, pumpback hydropower facilities, as described above, were evaluated. The preliminary arrangement of power features selected for the conventional alternatives were used and mechanical and electrical pumping features were incorporated with those major elements.

TABLE 16
PERTINENT DATA FOR SELECTED HYDROPOWER ALTERNATIVES
(October 1977 Price Level)

Reservoir	P.F.	Storage Allocation (1000 AF)	No. of Units	Capacity (Mw)	Ave. An. Energy (KWh x 10(6)	Hydropower Costs ($ million)
East Guilford	.05	194	2	32.8	19.4	49
Great Bend	.05	615	5	172	111	269
Keelersburg	.05	600	10	245	161	300
Keating	.05	625	6	586	316	344
Sinnemahoning	.05	113	1	24	16	43
Cammal	.05	282	2	140	82.8	123.3

TABLE 17

ANNUAL HYDROPOWER BENEFITS
(October 1977 Price Level)

Reservoir	Cap. Benefit ($1,000)	Energy Benefit ($1,000)	Hydropower Benefit ($1,000)
East Guilford	534	803	1,337
Great Bend	3,947	4,592	8,539
Keelersburg	6,027	6,6661	12,688
Keating	16,115	11,376	27,491
Sinnemahoning	312	662	974
Cammal	3,123	3,425	6,638

The net energy produced per year was determined as the diffeence between the generating energy and the pumping energy required for the pumping cycle. For each of the reservoirs investigated, it was determined that the differential in elevation between the forebay and the afterbay was not sufficient to make the initial construction cost of the reregulating dam and the reversible turbines economically feasible. The increased power benefits which could be obtained by a pumpback operation over that of a conventional alternative was clearly insufficient to justify the increased construction costs and the energy liability required for the pumping cycle.

Pumped Storage: For each of the six reservoirs under study, a cursory evaluation of adjacent pumped storage potential was considered. In a pumped storage project, the potential of the site is dependent upon a large differences in elevation between the forebay and the afterbay. In the adjacent-type of pumped storage project, a forebay is constructed high above but adjacent either to an existing reservoir, which provides water to operate the project and serves as an afterbay, or to a natural waterway which has sufficient streamflow for operating the project and which can be dammed to create an afterbay. Sites for adjacent pumped storage projects are characterized by a prominent hill or bluff adjacent to the reservoir.

Investigation of the sites was limited to a topographic evaluation foregoing any preliminary designs or cost estimates. Based on the preliminary criteria of having a minimal useable capacity of 6,000 - 10,000 acre-feet, two sites, one at Keating and one at Great Bend, were identified as having some potential. However, no further study was made on pumped storage because it was beyond the scope of the study.

Summary of Hydropower Alternatives: The results of the analysis of hydropower facilities at East Guilford, Great Bend, Keelersburg, and Sinnemanhoning indicate that further hydropower investigation was not warranted. The construction costs of hydropower features at Keelersburg, Great Bend, East Guilford, and Sinnemanhoning are high calculated on the basis of cost per kilowatt of capacity. Keating and Cammal costs are lower with Keating having the lowest dollar cost per kilowatt. Insufficient water would be available for economical power generation at the East Guilford and Sinnemanhoning sites. At Keelersburg and Great Bend sufficient water is available for power generation but the lack of head reduces the dependable capacity. The lack of head at East Guilford compounds the problem of insufficient water available at the site for power generation.

Cammal showed a good potential for hydropower; however, the section of Pine Creek where the Cammal project would be located is being considered for inclusion in the National Wild and Scenic Rivers Program and, as a result, the Commonwealth of Pennsylvania requested that no further study be made.

Only Keating was determined to have sufficient hydropower potential to be studied further. A second phase of study was accomplished for hydropower development for Keating and the more detailed results specifically concerning that site are presented later. During the first phase of study all the alternatives had significant amounts of unused power storage and it appeared that equal amounts of power could be generated utilizing less storage. Eight more alternatives were investigated in the second phase in an attempt to optimize the power storage.

Water Supply: Future consumptive demands for water will adversely affect the low flows on the waterways throughout the Susquehanna River Basin. In an effort to alleviate this problem, the Susquehanna River Basin Commission (SRBC) has adopted a regulation concerning make-up water for consumptive withdrawals within the Susquehanna River Basin. The SRBC regulation requires all consumptive water users which have become operational after January 1971, to compensate for all consumptive losses during a designated low flow period. This designated low flow period is defined as the lowest average discharge over a 7 day period that can be expected to occur every 10 years (Q7 - 10). The most obvious method of compensation is to allocate water supply storage in existing or planned reservoirs to provide the necessary make-up water.

After evaluating the reservoirs under consideration for flood control, hydropower and recreation, a fourth purpose, water supply, was added to two of the reservoir sites, Keating and Towanda. These reservoir sites were evaluated for their potential of providing make-up water for consumptive losses during low flow periods as described previously. The Keating site was selected because it had good potential for flood control and hydropower and it would augment the natural flow during low flow periods with the reregulated hydropower releases. The Towanda site was chosen because it was located in an advantageous position upstream from the major water consumers on the main stem of the Susquehanna River.

This evaluation was accomplished by performing operational studies to determine storage requirements to meet the downstream make-up water demands. Estimates of the water demands were obtained from the New York State Department of Environmental Conservation and the Pennsylvania Department of Environmental Resources and were presented in Table 6. The reservoir was subjected to a demand when the natural flow at a downstream point (for the purpose of this study Harrisburg was used because of the many consumptive users located in the vicinity) is below the desired flow (calculated from the critical low flow value, (Q 7-10), plus the specified consumptive demand). These operation studies were evaluated on a daily basis for the available period of record.

The results of these studies showed that the low flow augmentation resulting from the hydropower releases at Keating would easily be sufficient to meet all projected demands for make-up of the consumptive water losses downstream of the dam site and no additional storage, specifically for water supply, would be allocated. The minimum consumptive demand for the area downstream of Keating for 1990 was estimated at 300 cfs. The consumptive demand for the area downstream of Towanda is 350 cfs. The studies show that Towanda could only provide 315 cfs if all available storage was allocated for water supply.

Measurement of benefits for this water supply was accomplished by evaluating the cost of the most likely alternative measures for meeting the water supply need. For the purpose of this study, alternative single purpose water supply reservoirs were utilized as the most likely alternative. A water supply benefit analysis was developed for the Keating site because the water supply demand could be met by the hydropower releases and would not conflict with other uses. The water supply benefit developed for Keating was $9,500,000 with essentially no additional cost.

No water supply benefit evaluation has been accomplished for Towanda because the amount of storage necessary to supply the downstream demands would conflict greatly with the other uses and the project purpose would become primarily water supply. Single purpose water supply reservoirs are not within the authorized scope of this study. Also, since no evaluation of other water supply alternatives in this area have been made, the preliminary benefits for water supply that could be estimated may not be realistic. Other water supply alternatives may have much greater potential.

Conclusion: Of the twenty-two reservoir projects investigated as part of this study, nine reservoirs were eliminated from further study after evaluating the site for a single purpose flood control reservoir and thirteen reservoir sites were identified for further study. Using refined and updated basic data, the thirteen projects were again evaluated singly and in various combinations to test their flood control effectiveness. Each of the reservoirs was then evaluated for the additional purposes of recreation and hydropower. Recreation was added to all thirteen reservoirs and had a significant impact upon the benefits of some of the smaller sites evaluated. Hydropower was added to those reservoirs which had sufficient head and flow to produce significant hydro-electric power. Following evaluation of flood control, recreation, and hydropower, the Keating Dam was found to be the only potentially feasible reservoir site remaining and water supply for consumptive loss make-up water was added as a purpose. Towanda was also considered for potential water supply due to its location in the basin, however, as previously discussed no economic evaluation was made for water supply. The benefits for the various purposes, the annual costs, and the benefit to cost ratios for the thirteen reservoirs are shown on Table 18.

Of the thirteen reservoirs identified for further study during the systems analysis all but Keating were dropped due to a lack of economic justification and/or local support or both. All of the other sites lacked economic justification by a large margin as is shown in Table 18. The Cammal site was also dropped from further consideration at the request of the Pennsylvania Department of Environmental Resources since that section of Pine Creek was being considered for inclusion in the State's Scenic River program. The reservoirs located in New York State, i.e., Mount Upton, Copes Corner, Genegansiet, East Guilford, Purdy Creek, Mud Creek, and West Oneonta, received much opposition and no State or local support and further study was stopped for this reason.

Keating also lacked economic justification; however, it was recognized that the site has much more potential for implementation than the other reservoir sites and it appeared that optimization of the project purposes and storage would improve the economic justification

greatly. There has been a degree of local support for the Keating project, particularly from those seeking regional flood control. Due to these observations, a more detailed study was made for Keating. The resulting unpublished reconnaissance report is available in the Baltimore District and is summarized below.

The major objective of the study of Keating was to evaluate its potential as a flood control reservoir; however, as further study progressed it became evident that additional water resources problems and needs also could be satisfied by a reservoir at this location. The additional project purposes of recreation, hydropower, and water supply are investigated in a multiple purpose development to determine if the overall project would be economically justified.

Eight multiple purpose reservoir alternatives were investigated at the Keating site, with only the hydropower storage varying. The basic physical data for each of the alternatives is included in Table 19.

The optimum flood control storage was determined to be 250,000 acre feet or 3 inches of runoff. This amount of storage would reduce flood stages for a flood similar to the June 1972 flood by 8.2 feet at Renovo; 7.0 feet at Lock Haven, and 4.9 feet at Williamsport. Annual inundation reduction benefits for existing development and future development would be approximately $9,200,000 and $2,700,000, respectively.

The site was also evaluated for its potential of providing make-up water for consumptive losses during low flow periods. The study showed that the low flow augmentation resulting from the hydropower releases as modified by the re-regulating structure would meet all projected demands for make-up of the consumptive water losses downstream of the dam site. The resulting annual water supply benefits were estimated at $9,500,000.

Hydropower was evaluated with four different reservoir sizes and two different plant factors resulting in eight different hydropower alternatives. Each of the alternatives was a conventional hydropower project with a re-regulating dam to attenuate the power releases. The sizes and power capabilities of each of the alternatives are included in Table 19. Pump-back alternatives were also evaluated but these proved to have a lower economic efficiency. Table 20 lists the average annual hydropower benefits for each of the 8 alternatives.

The recreation potential was limited greatly due to the poor water quality (acid mine drainage), the steep slopes, the limited access, and the severe draw-down for hydropower. Since the recreation costs and benefits were not considered significant compared with the other project purposes, recreation was not considered in the overall economic project justification analysis.

Project cost estimates were developed to the level of detail necessary to compile an economic analysis. First cost and annual costs for each alternative are shown on Table 21. Also shown on Table 21 are the economic analyses of each of the alternatives including benefit-cost ratios and not benefits. Each of the reservoir alternatives have a significant contribution to flood control, hydroelectric power generation, and water supply but none are economically justified. The costs for a project at Keating are increased significantly due to the extreme length of the reservoir area which necessitates extensive railroad relocations, the very rugged terrain and the very high acidity of the water.

The more detailed study for Keating increased the B/C ratio to approximately 0.9 but it still it lacked economic justification, therefore no further study on Keating or any other reservoir site is recommended in this study.

TABLE 18

RESERVOIR ECONOMIC DATA
($1000)

(October 1977 Price Level)

Reservoir	Flood Control	Hydropower	Recreation	Water Supply	First Cost	Annual Cost	B/C Ratio
	ANNUAL BENEFITS						
West Oneonta	736		970	-	48,000	3,680	0.5
Mount Upton	2,160		1,430	-	104,000	7,180	0.5
Copes Corner	1,000		660	-	43,500	3,060	0.5
East Guilford	2,920	1,350	650	-	273,000	18,500	0.3
Great Bend	6,410	8,540	5,000	-	244,000	57,300	0.4
Genegansiet	931		680	-	46,900	3,280	0.5
Purdy Creek	310		160	-	14,000	1,040	0.5
Mud Creek	736		500	-	37,400	2,600	0.5
Towanda	725		1,490	-	61,600	4,350	0.5
Keelersburg	10,550	11,200	4,030	-	1,260,000	83,900	0.3
Keating	11,860	27,491	170	9,500	812,000	71,400	0.7
Sinnemahoning	10,630	819	370	-	313,000	21,100	0.6
Cammal	3,990	6,640	150	-	330,000	27,000	0.4

TABLE 19
KEATING DAM MULTIPLE PURPOSE ALTERNATIVES

ALTERNATIVE	ALLOCATION NUMBER	TOTAL STORAGE (acre-feet)	FLOOD CONTROL (acre-feet)	HYDROPOWER AND CONSERVATION (acre-feet)	ELEVATION MAX POOL (MSL)	CAPACITY (MW)	HYDROPOWER PLANT FACTOR)
1	1	1,450,000	250,000	1,200,000	1,050	700	.05
2	2	1,250,000	250,000	1,000,000	1,033	615	.05
3	3	1,050,000	250,000	800,000	1,010	500	.05
4	4	850,000	250,000	600,000	987	350	.05
5	1	1,450,000	250,000	1,200,000	1,050	175	.20
6	2	1,250,000	250,000	1,000,000	1,033	154	.20
7	3	1,050,000	250,000	800,000	1,010	125	.20
8	4	850,000	250,000	600,000	987	88	.20

TABLE 20
SUMMARY OF ANNUAL HYDROPOWER BENEFITS FOR KEATING ALTERNATIVES ($1,000 October 1977 Price Level)

	ALTERNATIVE							
BENEFITS	1	2	3	4	5	6	7	8
Capacity	$19,200	$16,900	$13,700	$ 9,600	$ 4,800	$ 4,200	$ 3,400	$ 2,400
Firm Energy	10,900	9,600	7,800	5,500	10,300	9,100	7,400	5,100
Secondary Energy	1,000	1,000	1,400	2,100	900	900	1,300	2,000
Total	$31,000	$27,500	$22,900	$17,200	$16,000	$14,200	$12,100	$ 9,500

The interest in and emphasis on hydroeletric power development has recently increased significantly due to the energy crisis. The current National Hydroelectric Power Resources Study (NHS) includes an assessment of the Nation's hydroelectric power resources under current and most likely future energy conditions. Due to increased interest the hydropower potential at several sites in the Basin, including Keating, are being evaluated as part of the NHS.

Small Upstream Reservoirs

Upstream reservoirs are situated on small tributaries to the main stem of a river and generally control relatively small drainage areas. A general description of these projects is included in the Possible Solution Section of this report.

The Watershed Protection and Flood Protection Act, Public Law 89-566, authorized the Secretary of Agriculture acting through the Soil Conservation Service (SCS) and the Forest Service to provide technical and financial assistance to local organizations in planning and carrying out watershed projects. The watershed projects are for flood protection, recreation, fish and wildlife development, municipal and industrial water supply and agricultural water management which includes irrigation and drainage.

For this study the SCS reviewed their ongoing program to determine if there were any additional watershed projects which appeared to have potential of meeting flood damage reduction needs within the Susquehanna River Basin and the criteria used in formulating and evaluating the basin plan. Under their current program, SCS has been authorized to do planning on three watersheds. These are located in the Commonwealth of Pennsylvania and shown on Figure 16: Chickies Creek, Lancaster County; Quitapahilla Creek, Lebanon County; Upper Tioga River, Tioga County; Brandywine Creek Watershed in Broome County, New York. In addition to these ongoing studies, SCS has applications pending for studies of six watersheds shown on Figure 16 and listed in Table .

For each of these watersheds, a field examination will be made to determine if a detailed study of a project should be made. Plans which warrant a more detailed examination will be referred to the State Conservation Commission for authorization of planning. The review performed by SCS failed to identify any additional structural watershed projects which warrant further study.

Headwater Reservoir System

A headwater reservoir is one which is located upstream on a tributary to a main stem river. The purpose of this analysis is to provide a comparison of the flood damage reduction potential between a system of headwater reservoirs and a major reservoir in the same area of the river basin. The flood damage reduction which could be provided by a system of headwater reservoirs was measured at locations downstream of the major reservoir with which the system was compared.

The damage reductions were measured only for a Tropical Storm Agnes and not for a range of storms as would be necessary to compute the reduction in average annual damages. This comparison is sufficient to provide data for the purpose of comparing the effectiveness of two alternatives but does not provide adequate information to determine the economic feasibility of either project.

TABLE 21

SUMMARY OF ECONOMIC ANALYSIS FOR KEATING ALTERNATIVES ($1,000 October 1977 Price Level)

	ALTERNATIVES							
ITEMS	1	2	3	4	5	6	7	8
INVESTMENT COST								
First Cost	$ 855,300	$787,600	$688,300	$575,700	$568,800	$536,800	$484,300	$432,800
Interest During Construction*	198,000	182,600	159,600	133,500	131,900	124,500	112,300	100,400
Total Investment	1,053,600	970,200	847,900	709,200	700,700	661,300	596,600	533,200
ANNUAL COST								
Interest and Amortization	69,000	64,400	56,300	47,100	46,500	43,900	39,600	35,400
Operation and Maintenance	7,100	400	5,200	3,700	1,900	1,700	1,400	2,000
Total Annual Cost	77,000	70,800	61,500	50,800	48,400	45,600	41,000	36,400
Total Annual Benefits	55,160	51,360	46,360	40,260	39,060	37,160	34,860	32,160
Benefit-Cost Ratios	0.7	0.7	0.8	0.8	0.8	0.8	.0.9	0.9
Net Economic Benefits	-22,840	-19,440	-15,140	-10,540	-9,340	-8,440	-6,140	-4,240

*Based on a 7 year construction period


Cooperstown
Binghamton
Elmira
Athens
Upper Tioga River
Scranton
Williamsport
Lock Haven
Sunbury
Kishacoquillas Creek
Altoona
Spring Creek
Wiconisco Creek
Chickies Creek

Figure 16

Headwater reservoirs generally have a flood control storage volume ranging from a few hundred acre-feet to about 5,000 acre-feet and are located on drainage areas ranging from 1 to 50 square miles with the majority being on drainage areas less than 15 square miles. These projects are commonly associated with agricultural flood control programs.

Functional and structural features incorporated in such reservoirs are relatively simple, and standards of safety against overtopping by infrequent floods are much lower than are normally required where protection of urban area is involved.

TABLE 22

WATERSHED PROJECTS

SCS APPLICATION PENDING

New York	Pennsylvania
Canasawacta Creek, Chenango County	Bentley Creek, Bradford County
	Wisconisco Creek, Dauphin County
	Kishacoquillas Creek, Mifflin County
	Little Mahanoy Creek, Schuylkill County
	Spring Creek, Dauphin County

The dams normally have ungated outlets, sized to limit reservoir outflow to approximately an average of 5 cfs per square mile until the reservoir pool exceeds the emergency spillway crest elevation and free overflow occurs. Some reservoirs may have small conservation pools regulated by valved outlets when pool levels are below the bottom of the flood control pools. Dams usually consist of rolled-fill earth or rock embankments.

From an initial look at the physical characteristics of the potential headwater reservoirs, it is evident that these sites have very limited amounts of flood control storage in comparison to the magnitude of flood control storage normally associated with major flood control reservoirs. It can be concluded that singularly any of these potential reservoirs would provide minimal damage reduction at locations on the main stem of the river.

Method of Analysis: To determine the effectiveness of a system of headwater reservoirs, an analysis was made of a system of 34 reservoirs in the headwaters of the West Branch of the Susquehanna River (Figure 17). The analysis consisted of determination of the modified hydrograph for the Tropical Storm Agnes flood for each of the subbasins where potential headwater sites were located. A computer program HEC-1 (Flood Hydrograph Package) was utilized to determine the modified hydrographs using basic watershed characteristics which were developed for each subbasin and reported in Appendix D of the Susquehanna River Basin Study completed in June 1970. Computation of the modified flood hydrographs for each of the subbasins allowed for the determination of reservoir effectiveness at the subbasin limit. In order to determine the effectiveness of this system of reservoirs at location further downstream, it was necessary to include other variables into this analysis. The existence of major reservoirs in some of the subbasins of the West Branch is a factor that has an impact on the reduction in flood stages at downstream locations due to the headwater reservoirs. The releases made from the major reservoirs during a potential flood situation are based on a non-damaging flow at certain critical downstream areas. If the flows from other subbasins are reduced by some means, such as the presence of headwater reservoirs, the major reservoirs,

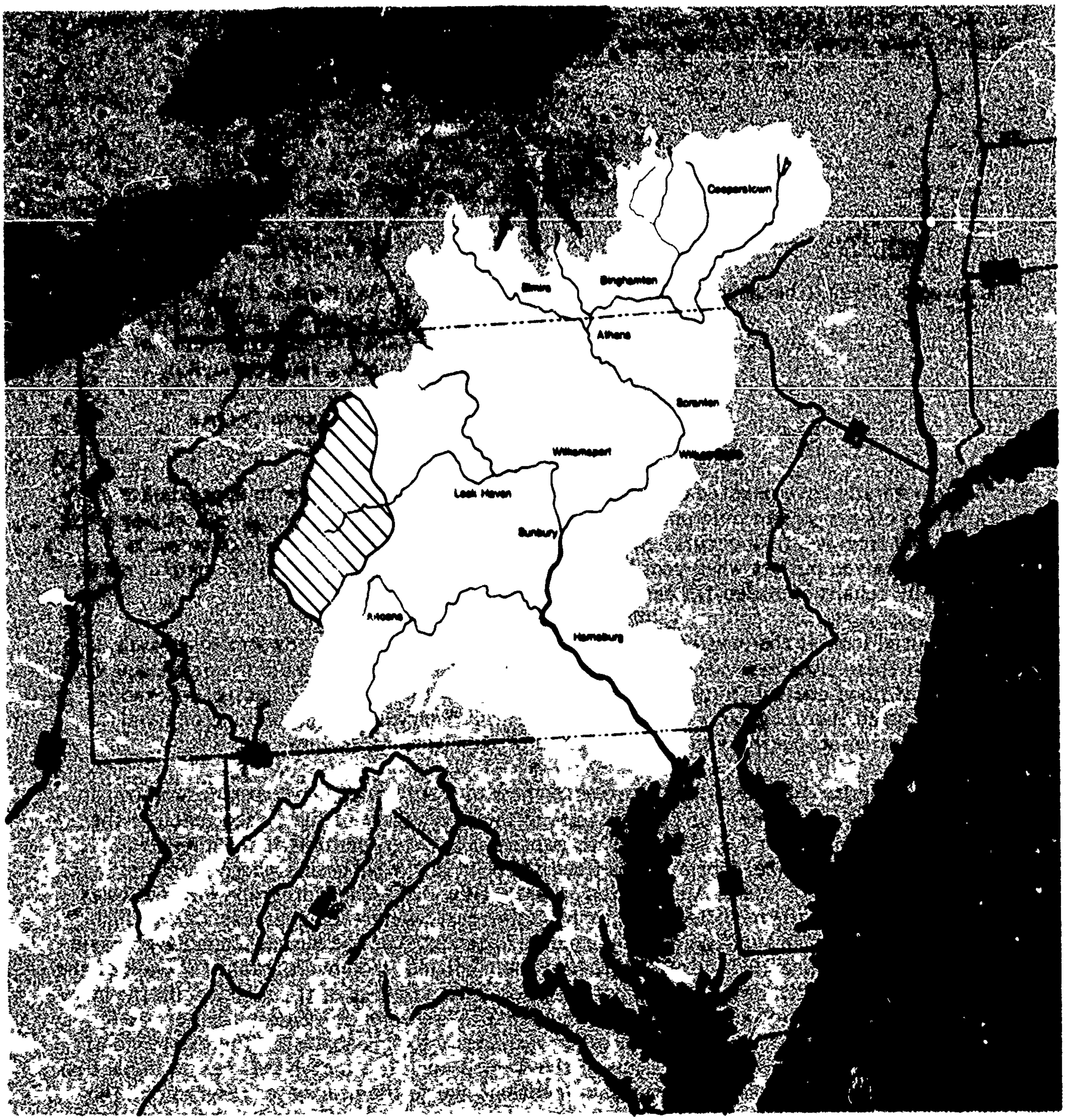

Cooperstown
Elmira
Binghamton
Athens
Scranton
Williamsport
Lock Haven
Sunbury
Harrisburg

Figure 17

which can control its releases, can release additional flows without exceeding the non-damaging flow at the critical area. In certain subbasins, potential headwater reservoirs are located upstream of major reservoirs and in this case, the operation of the existing reservoirs would also be modified.

To incorporate these modifications in reservoir operation into the analysis it was necessary to use a computer program HEC-5C, Simulation of Flood Control and Conservation Systems. In addition to many other features, this program allows specification of reservoir release parameters such as non-damaging flows at critical downstreams areas. This program accepts the modified storm hydrographs from the HEC-1 program as input which are then hydraulically routed through each successive river segment and combined with other hydrographs. A system of control points are established up on which the total system is based. Each control point represents either a reservoir, a specific point of interest (town, stream gage), or a junction where hydrographs are to combine. At any of the non-reservoir control points, the user can input data which will allow an economic analysis of conditions being simulated.

This program provides an analysis of the inflow hydrographs and reservoir operation in the form of reduction in flows, stage and average annual damages at the control points desired. Base conditions are input for average annual damages in order to obtain reductions which can attribute to the modified operation of the existing reservoirs.

Once the desired information is obtained for the system of headwater reservoirs, it was compared with data that demonstrated the effectiveness of the potential Keating reservoir on the West Branch.

Watershed characteristics for each of the potentially controlled areas were derived from generalized information used in the 1970 Susquehanna River Basin Study. Where this type of information was not available, assumptions were made based on the given information for each of the individual subbasins.

Reservoir data for each of the potential headwater sites included in the study were supplied by the Harrisburg office of the SCS. These data were developed by SCS in conjunction with the 1970 Susquehanna River Basin Study. In May of 1968, SCS published a report entitled, "Inventory of Potential Upstream Reservoir Sites" which contained data about each potential site which were valuable in screening the vast number of sites down to those which had some flood control potential.

Many of the sites identified as potential reservoirs in the SCS document have limited value as flood control structures because of the requirements for sediment storage, beneficial storage or both which results in a lack of flood control storage. Because of this, the potential sites were screened to identify only the effective sites. The screening consisted of selecting only those flood control reservoir sites which had a drainage area greater than 3.0 square miles and a flood control storage area greater than 3.0 inches of runoff. The flood control storages ranged from 479 to 7140 acre-feet. In selected cases where the potential site had a sufficiently large drainage area sites with flood control storage as low as 2.0 inches of runoff were included. The total storage for all 34 sites was 68,063 area-feet and the total area inundated at the spillway crests was 5613 acres.

Releases from the reservoirs were based on a generalized procedure since outlet size and spillway length were not available for all of the sites. For the purpose of this study releases were based on a 30 inch diameter conduit, with its top elevation located at the bottom of the flood control pool. The emergency spillway discharges for each site were based on a 400 foot long spillway crest. The elevation of each crest was set equal to the top of their respective flood control pool.

Reservoir cost data was also furnished by SCS. These cost estimates were first prepared between 1966 and 1968. For this comparative analysis of the "Engineering News Record" construction cost index was used to update the construction cost to October 1977 price level. The total construction cost for all 34 sites was $130,100,000.

Conclusions: Tables 23 through 25 present the flood stage and flood discharge reductions provided by the system of headwater reservoirs analyzed. Tables 23 and 24 show the effect at locations on the West Branch of the Susquehanna River Basin while Table 25 shows the effects at the subbasin limits. As can be seen, the reductions measured at the locations downstream of the system are relatively insignificant. In Table 23 the discharge reductions measured against the natural (without existing major reservoirs) conditions are shown. The system of headwater reservoirs produced no discharge reductions at any of the downstream locations. Table 25 shows the discharge reductions for the natural conditions measured at the subbasin limits. These show that some reductions would be provided by the system and seem incompatible with the results presented in the previous table. However, an examination of the natural and modified hydrographs shows that, although the flood peaks are reduced at the subbasin limits, the timing of the modified peaks is delayed. Combining of the modified peaks nullifies the individual reductions because the peaks now more nearly coincide.

Table 24 shows that limited reductions could be expected with the headwater reservoir system in addition to the existing system of major reservoirs. The reason for this is that the headwater reservoirs do provide some discharge reduction, as shown in Table 25 and, as a result, the major reservoirs are able to store additional amounts of run-off.

In general, the results show, the headwater reservoir system analyzed would not be an effective means of providing flood stage reduction for locations on the main stem of a river. Although the analysis was performed for a system in the West Branch of the Susquehanna River, similar results can be expected for any other portion of the Basin. For this reason, further analysis of this flood damage reduction measure was not performed.

Structural Local Flood Protection

Initial stages of the plan formulation process for structural local flood protection projects (LFP's) involved a complete review of the results of the 1970 Susquehanna River Basin Study. As part of the 1970 study, structural LFP's were considered in varying degrees of detail for 288 flood damage centers located on the main stem and major tributaries of the Susquehanna River. Locations evaluated during the 1970 Susquehanna River Basin Study where projects were found to be infeasible based on either engineering judgment considerations or very preliminary economic and engineering analysis, were not reevaluated as part of this study. In most cases the potential for damage within these communities represented a small proportion of the total damage attributable to flooding within the Susquehanna River Basin. Areas where sufficient data was available to reevaluate feasibility of a project or where public interest in flood control surfaced subsequent to Tropical Storm Agnes were evaluated for project feasibility in this study.

Approximately 88 locations, which represented the most significant damage centers within the Susquehanna Basin, were indentified for evaluation. This analysis for these areas involved updating flood damage estimates based on changes in flood plain development and recent flood experiences, incorporating current hydraulic and hydrologic data, considering changed economic parameters (i.e., unit costs, interest rate, revised benefit analyses procedure, etc.), and a determination of the appropriateness of the type of flood control project considered in the 1970 study. The level of detail for a particular flood prone community was generally in line with that included in the 1970 Susquehanna River Basin Study, which focused primarily on engineering and economic feasibility.

TABLE 23

HEADWATER RESERVOIR REDUCTIONS
OF AGNES NATURAL[1/] FLOWS
AT DOWNSTREAM LOCATIONS

Location	Natural Peak Flows-Agnes (cfs)	Natural w/HWR Peak Flows (cfs)	Peak Flow Reduction by HWR* (cfs)
Karthas	110,000	112,000	-2,000
Renovo	202,000	204,000	-2,000
Lock Haven (upstream)	212,000	262,000	0
Lock Haven (downstream)	273,000	274,000	-1,000
Williamsport	377,000	379,000	-2,000

*HWR - Headwater Reservoir
1/ Flows which would have occurred without any of the existing upstream reservoirs in place.

TABLE 24

HEADWATER RESERVOIR REDUCTIONS
OF EXISTING[2/] AGNES FLOWS
AT DOWNSTREAM LOCATIONS

Location	Existing Peak Flows (cfs)	Stage	Existing w/HWR* Peak Flows (cfs)	Stage	Reduction by HWR* Peak Flow (cfs)	Reduction by HWR* Stage (ft)
Karthas	83,600	4.5	85,571	4.7	-1,971	-0.2
Renovo	147,000	10.5	144,784	10.3	2,216	0.2
Lock Haven (upstream)	159,000	9.5	156,987	9.3	2,013	0.2
Lock Haven (downstream)	201,000	—	196,971	—	4,029	—
Williamsport	311,000	18.4	304,730	17.9	6,270	0.5

*HWR - Headwater Reservoir
2/ Flows include effect of all existing upstream reservoirs.

TABLE 25

HEADWATER RESERVOIR REDUCTION
OF NATURAL[1/] AGNES PEAK FLOWS
AT SUBBASIN LIMITS

Subbasin	Existing Flow (cfs)	Flows Modified by HWR* (cfs)	% Reduction
181	29,549	28,581	3
182	15,382	15,055	2
183	35,605	35,716	-.3
184	22,641	22,795	-.5
185	27,812	24,970	10
187	30,669	17,051	44
188	60,082	58,207	3
189	32,128	26,139	19

*HWR - Headwater Reservoir

1/ Flows which would have occured without any of the existing upstream reservoir in place.

Scope of Engineering and Cost Analyses: The engineering and cost analyses performed for these 88 locations were in sufficient detail whereby a reasonable decision concerning economic justification could be attained. The engineering analyses performed for these areas consisted of hydrologic, hydraulic, and structural design of the most applicable flood control measures. In most cases the potential flood control alternative was analyzed for three flood levels consisting of the flood of record, the standard project flood, and an intermediate flood. Based on the evaluation performed for these flood levels, trends indicating cost vs. degree of protection were analyzed to determine the most "cost effective" level of protection for the plan under consideration. In some cases more than one flood control of alternative was evaluated.

Hydrologic and Hydraulic Analysis: Hydrologic information for each area under consideration consisted of both stage-discharge and discharge-frequency relationships. Stage-discharge information was taken primarily from information developed by USGS. In some instances, the particular stage-discharge information needed was not available from USGS. Consequently an effort was made to obtain this information from other sources or to develop the information based on reliable channel cross section data. Other sources of information included the Soil Conservation Service, National Weather Service, State Department of Transportation, and other public agencies requiring the use of such data.

Discharge-frequency relationships used in this study were primarily those agreed upon by members of the interagency Hydrologic Data Coordinating Committee which includes, among others, the Corps of Engineers, Susquehanna River Basin Commission, and the United States Geological Survey. If no stream gage was sufficiently close to the area under consideration, generalized or regional type frequency relationships were computed in accordance with paragraph "Generalized Flood Frequency Relations" of the "Hydrologic Study, Tropical Storm Agnes", North Atlantic Division, Corps of Engineers, December 1975. This method defines the annual maximum flood peaks utilizing three parameters consisting of the mean, standard deviation, and skew coefficient of the log-Pearson Type III distribution. Another method, utilized in a few instances, to estimate frequency of flooding involved a graphical approach. By

this method, frequencies are evaluated simply by arranging observed flow values in order of magnitude. Each value represents a fraction of the future possibilities and, when plotting the frequency curve, it is given a "plotting position" that is calculated to give it proper weight.

For some locations, hydraulic analyses, consisting of the determination of water surface profiles were performed in order to insure the level of protection for a particular flood control plan. For levee projects the hydraulic analyses also consisted of preliminary design of interior drainage structures. For channelization projects, hydraulic analyses consisted of determination of type, size, and materials needed to adequately protect against the design flow. Such indicators as depth, side and bottom slopes, top width, type of material, velocity of flow, coefficients of friction, etc., entered into the hydraulic analysis.

Structural Analysis: Design of the structural components for each flood control alternative was based on typical design sections. These data consisted of levee sections, wall sections (standard gravity, L-shaped and inverted T-type), and channel sections, as shown in Figure 18. Components of the levee sections included stripping, trench excavation, impervious fill riprap, and seed and sod. Quantities for the above components were calculated for various heights of levee for the typical section. Components of the floodwalls include quantity estimates for stripping, excavation, concrete volume, backfill, seeding, steel, and cement for various wall heights. Other components for which typical design was performed consisted of pump stations, closure structures, channel clearing and snagging, channel excavation, pressure conduit, underseepage treatment, bridges and drainage structures. It should be emphasized here that the detail involved in the design of the above items was of a preliminary nature. A more detailed level of analysis would be performed if the analysis at this level of study showed possible economic justification.

Costs: Preliminary cost estimates were made for each level of protection. For each location evaluated, the plan of protection was laid out on a topographic map and the location, extent, and elevation of the protective measures determined.

Costs which were utilized during this level of analysis were in the form of unit and lump sum costs based on volume, area, length, capacity, quantity, etc. Again, it should be emphasized that during the course of this study, various costs for the same items were utilized. However, relative costs were used during each iterative step for all communities leading to identification of the most economically justifiable projects. Unit prices used in estimating the cost of the local flood protection projects in this study were based on the estimated cost of similar projects in the Susquehanna River Basin. Contingency costs were 25 percent of the first cost and the cost of engineering, design, supervision, and administration was estimated as 15 percent of the first cost plus contingencies. Sample unit costs ranges, utilized during the course of this study for various cost items, are shown in Table 26. These costs are based on October 1977 price levels and do not include contingencies, engineering and design, and supervision and administrative costs.

The land required for the construction of a local protection project was based on the amount of space occupied by a protective structure with an allowance for working areas and rights-of-way. The alignment of the protective works was adjusted to affect as few buildings as possible. Costs for lands and buildings were developed from estimates prepared by real estate appraisers taking into account characteristics typical of the Susquehanna River Basin. Pumping stations were provided, were required, to dispose of drainage collected within the protected area during floods. The preliminary costs of pumping stations for this study were based on the cost of pumping stations constructed at other local flood protection projects. Closure structures were provided for each opening designed to allow passage of a road or railroad through the protective works. The cost of these closure structures was based on a prefabricated

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metal structure which could be stored adjacent to the opening and quickly assembled when needed.

Results of Preliminary Evaluations: Subsequent to compilation of all design, cost, benefit, and benefit-to-cost ratios (BCR), criteria were established to determine which of the 88 locations should receive further study. The preliminary criteria was attaining a benefit-cost ratio of 0.5 or greater. It was felt that study of locations showing a BCR less than 0.5 would not result in justified projects, even if more refined analyses were performed for these locations. Areas considered for further study are listed in Table 27 and shown on Figure 19. The communities of Owego and South Corning, New York, were not selected on the basis of this 0.5 limit, but rather on public interest and indications obtained from field investigations, that further study would be warranted for these communities. A complete listing of preliminary results of the evaluations of all communities are shown in Table 28.

Further Study of Remaining Communities: As discussed above, evaluations of various structural local flood protection alternatives for the many locations throughout the Susquehanna River Basin led to identification of ten communities (see Figure 19 and Table 27) which warranted further investigation.

Reconnaissance level studies were conducted for these communities. This evaluation consisted of review of the existing data and accomplishment of more detailed engineering and design evaluations. Of prime importance was the data review to insure accuracy of all stage-damage, hydraulic and hydrologic, and design information which had previously been evaluated. In addition a field visit was made to verify base conditions. The purpose of this field trip was to determine:

1. If the plan being identified provided an adequate degree of protection.

2. If there were any adverse physical conditions that would affect project alignment.

3. If any obvious adverse geologic conditions existed.

4. It a correct base for the damage potential was used.

5. If correct base for quantity estimates was used.

6. If implementation of the measure under consideration would have extreme environmental or socio-economic impacts on the area.

Modifications were then incorporated into the analyses as a result of this further review and site visit. The results of the analyses are shown in Table 29 which indicates that the alternatives evaluated for both Binghamton, New York, and Williamsport, Pennsylvania, appear to be feasible.

Conclusions: The evaluation of the feasibility of structural flood protection for over 288 locations in the Susquehanna River Basin has resulted in the identification of only two potential projects which warrant detailed study. These potential projects are raising the existing protection at Binghamton, New York, and Williamsport and South Williamsport, Pennsylvania. A summary of the reconnaissance level studies conducted for these two communities is given below.

Local Flood Protection Measures

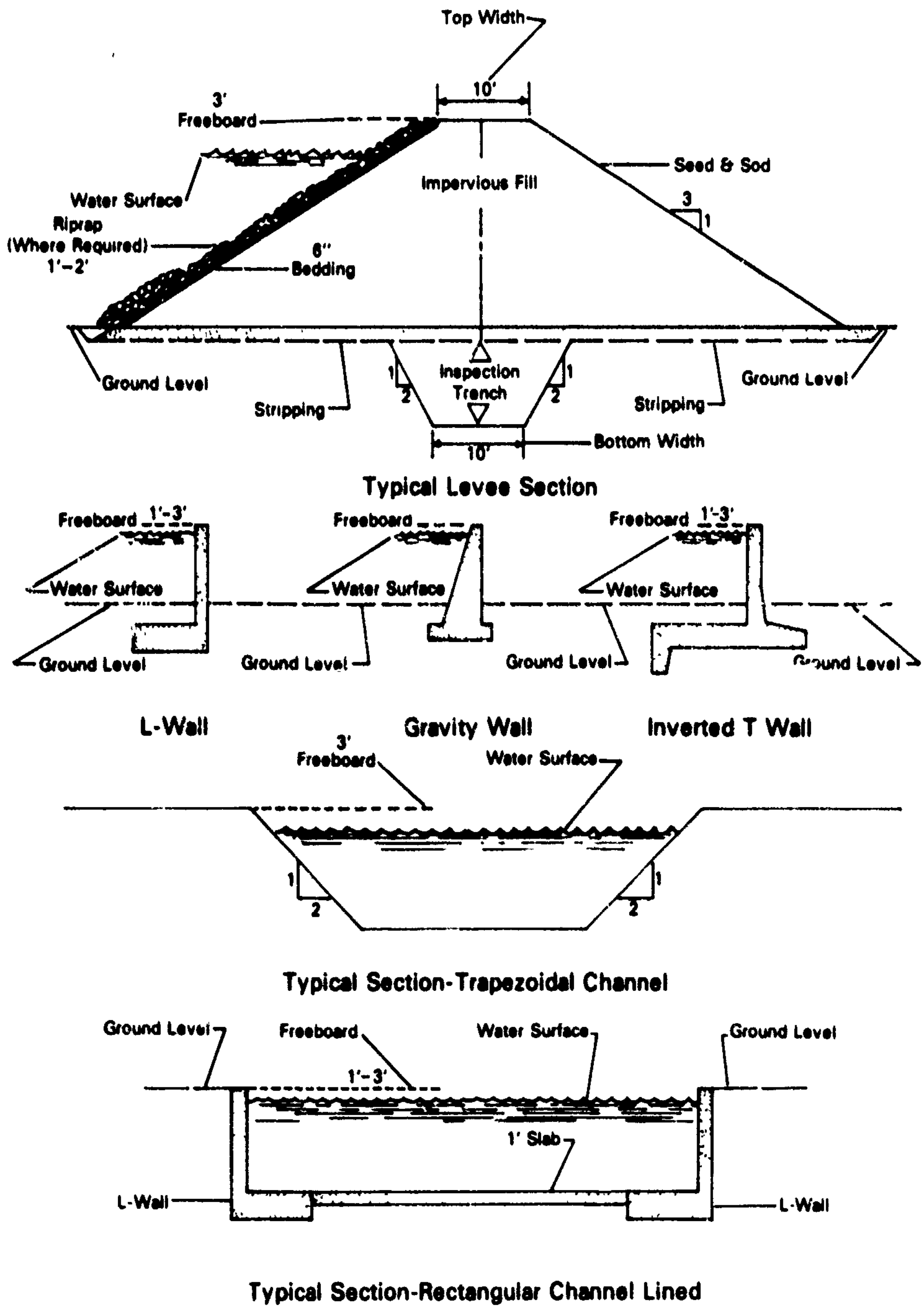


Figure 18

TABLE 26

SAMPLE UNIT COST RANGES
(Oct 1977 Price Level)

Cost Items	Range	Unit
Excavation	\$2.50 - \$31.00	cy
Riprap	\$31.00 - \$44.00	cy
Bedding Material	\$20.00 - \$25.00	cy
Concrete	\$188.00 - \$275.00	cy
Backfill (Compacted)	\$8.00 - \$11.50	cy
Stripping	\$0.40 - \$1.50	sy
Seeding	\$0.40 - \$1.50	sy
Cement	\$13.75 - \$16.25	bbl
Steel	\$0.50 - \$0.87	lb
Clearing & Grubbing	\$625.00 - \$1500.00	acre
Clearing & Snagging	\$1875.00	acre

a. Binghamton, New York

Location: The City of Binghamton is located at the confluence of the Chenango River and the Susquehanna River in Broome County, New York. Binghamton is part of the highly urbanized Triple Cities areas and has major industries producing photographic film, computers, electronic equipment, and shoes. Rail service is provided by the Consolidated Rail Corporation (ConRail), and the major highways are Interstate 81 and New York State Route 17. The total drainage area for both rivers at the confluence is about 3,890 square miles. Binghamton is located in the Appalachian Plateau, which is characterized by wide, flat valleys with steep sides and gently rolling hills. The population, based on the 1970 census, is 64,123, a decrease of about 16 percent from 1960. The location of the city is shown on Figure 20.

Flood Problem: Prior to completion of the existing system of protective works in 1950, Binghamton was subject to frequent and damaging floods. The largest flood on the Susquehanna River occurred in March 1936, which produced a flow of 61,600 cfs at the Conklin, New York, USGS stream gage. The largest flood on the Chenango River occurred in July 1935 which produced a flow of 96,000 cfs at the Chenango Forks, New York, USGS stream gage. Both floods are still the floods of record. Since completion of the present system, which consists of levees, floodwalls, channel improvements, and one reservoir in each basin upstream of the confluence, no major damage has occurred within the protected area. Based on original design capacities, the existing system is designed to provide protection against a flow of 75,000 cfs on the Chenango River and 80,000 cfs on the Susquehanna River. Based on the most recent flow-frequency curves within the Baltimore District, an existing level of protection of approximately 180 years is realized on the Chenango River while on the Susquehanna River, a higher level of protection is realized.

TABLE 27

COMMUNITIES CONSIDERED FOR FURTHER STUDY OF LOCAL FLOOD PROTECTION

Community	Type of Project	Annual Benefits	Annual Costs	BCR
Addison, New York	Extend existing protection	$9,500	$9,760	0.97
Binghamton, New York	Raise existing protection	$3,584,300	$3,714,474	0.96
Conklin-Kirkwood & vicinity, NY	Channel modification	$217,490	$40,450	5.4
Endicott, New York	Raise existing protection	$269,420	$55,475	4.8
Harrison Valley, Pennsylvania	Levee or channel modification	$50,620	$48,870	1.0
Muncy, Pennsylvania	Levee and floodwall	$1,189,800	$991,000	1.2
Owego, New York	Levee	--	--	*
South Corning, New York	Extend existing protection	--	--	*
Westfield, Pennsylvania	Channel modification	$183,750	$94,630	1.9
Williamsport, Pennsylvania	Raise existing protection	$518,990	$575,420	0.9

*Carried further based on public interest and field review.

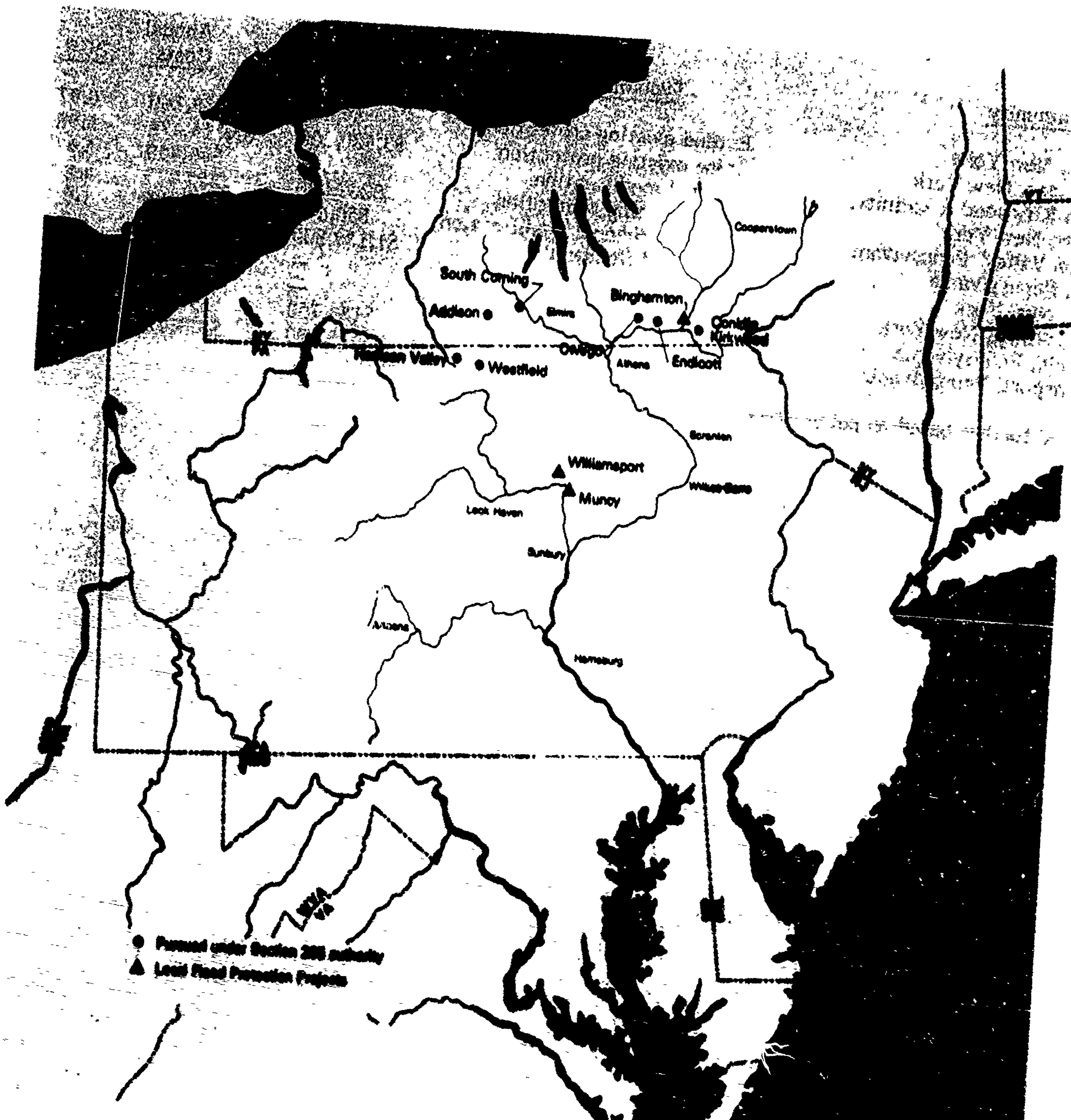

Cooperstown
South Corning
Addison
Elmira
Binghamton
Conklin
Kirkwood
Owego
Athens
Endicott
Westfield
Scranton
Williamsport
Wilkes-Barre
Muncy
Lock Haven
Sunbury
Harrisburg
Pursued under Section 205 authority
Local Flood Protection Projects

Figure 15

TABLE 28

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further?
Academy Corners, PA	Cowanesque River	Levee	No; B/C = 0.08
Addison, NY	Canisteo River	Exist. Corps' proj.	Yes; B/C = 0.97
Afton, NY	Susquehanna River	--	1
Alexandria, PA	Frankstown Branch	Levee	1
Altoona, PA	Little Juniata R.	--	1
Amity Hall, PA	Susquehanna River	--	1
Archbald, PA	Lackawanna River	Levee	No; B/C = 0.17
Arkport, NY	Canisteo River	--	1
Ashley, PA	Wapwallopen Creek	--	1
Athens, PA	N. Br. Susq. River	Existing St. Proj.	2
Avis, PA	Pine Creek	Levee	No; B/C = 0.05
Avoca, NY	Cohocton River	Exist. Corps' proj.	2
Bainbridge, NY	Susquehanna River	Exist. Corps' proj.	2
Bald Eagle, PA	Little Juniata Riv.	--	1
Barton, NY	Susquehanna River	Levee	No; B/C = 0.08
Bath, NY	Cohocton River	Exist. Corps' proj.	2
Bedford, PA	Shawnee Branch	Levee	No; B/C = 0.08
Beech Creek	Beech Creek	--	1
Bellwood, PA	Little Juniata Riv.	Levee	No; B/C = 0.43
Berwick, PA	N. Br. Susq. River	--	1
Big Flats, NY	Chemung River	Levee	2
Binghamton, NY	Susquehanna River	Levee Raising	Yes; B/C = 0.96
Blain City, PA	Sherman Creek	Existing Project	2
Blakely, PA	Lackawanna River	Levee	No; B/C = 0.20
Bloomsburg, PA	N. Br. Susq. Riv.	Levee & Channel	No; B/C = 0.23
Blossburg, PA	Tioga River	Floodwalls & Chan.	No; B/C = 0.27
Brisben, NY	Chenango River	Levee	No; B/C = 0.48
Brooklyn, PA	Martins Creek	--	1
Burnham, PA	Kishacoquillas Cr.	Levee	1
Campbell, NY	Cohocton River	Chan. Improve.	No; B/C = 0.07
Candor, NY	Catatonk Creek	--	1
Canisteo, NY	Canisteo River	Exist. Corps' proj.	2
Cannon Hole, NY	Susquehanna River	Levee	No; B/C = 0.22
Carbondale, PA	Lackawanna River	Levee	1
Castle Gardens, NY	Susquehanna River	Levee	No; B/C = 0.32
Catawissa, PA	N. Br. Susq. River	Levee	No; B/C = 0.01
Cayuta, NY	Cayuta Creek	Levee	No; B/C = 0.10
Center Village, NY	Susquehanna River	Levee	No; B/C = 0.40
Chenango Bridge, NY	Chenango River	Levee	No; B/C = 0.63
Chenango Forks, NY	Chenango River	Levee	No; B/C = 0.20
Cincinnatus, NY	Otselic River	Exist. Corps' proj.	2

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further?
Claysburg, PA	Frankstown Branch	Levee	1
Clearfield, PA	West Branch	Levee	No; B/C = 0.11
Cly, PA	Susquehanna River	Levee	No; B/C = 0.06
Coalport, PA	Clearfield Creek	Exist. State LFP	2
Conklin-Kirkwood & vicinity, NY	Susquehanna River	Chan. Improvement	Yes; B/C = 5.4
Conklin Station, NY	Susquehanna River	Levee	No; B/C = 0.20
Conodoguinet Creek Area, PA	Susquehanna River	Levee	No; B/C = 0.09
Coopers Plains, NY	Cohocton River	Chan. Improvement	No; B/C = 0.22
Corning, NY	Chemung River	Exist. Corps' proj.	2
Cortland, NY	Tioughnioga River	Exist. Corps' proj.	2
Cove Area, PA	Susquehanna River	Levee	No; B/C = 0.15
Covington, PA	Tioga River	Levee	No; B/C = 0.52
Cuba Mills, PA	Juniata River	Levee	No; B/C = 0.02
Curwensville, PA	West Branch	Channel	No; B/C = 0.14
Dalmatia, PA	Susquehanna River	Levee	No; B/C = 0.07
Danville, PA	N. Br. Susq. River	Exist. State LFP	2
Dauphin, PA	Susquehanna River	Levee	No; B/C = 0.03
Dewart, PA	West Branch	Levee	No; B/C = 0.07
Dickson City, PA	Lackawanna River	Exist. State LFP	2
Drury Run, PA	Drury Run	--	1
Duboistown, PA	Drury Run	Levee	No; B/C = 0.05
Duncan Island, PA	Susquehanna River	Levee	No; B/C = 0.3
Duncannon, PA	Susquehanna River	Levee & floodwalls	No; B/C = 0.10
Duncansville, PA	Frankstown Branch	Channel Improve.	1
Duryea, PA	Lackawanna River	Levee	No; B/C = 0.46
East Freedom, PA	Frankstown Branch	--	1
Edmeston, NY	Susquehanna River	Under SCS Consid.	--
Elkland, PA	Cowanesque River	Exist. Corps' proj.	2
Elmira, NY	Chemung River	Exist. Corps' proj.	2
Elmira Heights, NY	Newtown Creek	Levee	No; B/C = 0.5
Emporium, PA	Sinnemahoning Cr.	Exist. State LFP	2
Endicott, NY	Susquehanna River	Levee Raising	Yes; B/C = 4.8
Endwell, NY	Susquehanna River & levee	Chan. Improvement	No; B/C = 0.05
Enola, PA	Susquehanna River	Levee	No; B/C = 0.07
Espy, PA	N. Br. Susq. River	Levee	No; B/C = 0.14
Everett, PA	Raystown Branch	Exist. State Levee & Chan. Improve.	2
Exeter, PA	N. Br. Susq. River	--	1

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further?
Fairmont Park, NY	Susquehanna River	Levee	No; B/C = 0.52
Falls, PA	N. Br. Susq. River	Channel	1
Fernville, PA	N. Br. Susq. River	Self-help flood prot. project	--
Fitch Br. Area, NY	Chemung River	Levee	No; B/C = 0.01
Flemington, PA	Bald Eagle Creek	Levee	No; B/C = 0.03
Fort Hunter, PA	Susquehanna River	Levee	No; B/C = 0.2
Frankstown, PA	Frankstown Branch	--	1
Gang Mills, NY	Tioga River	Exist. State prot.	1
George Town, NY	Otselic River	Levee	1
*Gibson, NY	Chemung River	Levee	No; B/C = 0.03
Goldsboro, PA	Susquehanna River	Levee	No; B/C = 0.04
Great Bend, PA	Susquehanna River	Levee	1
Green, NY	Chenango River	Exist. Corps' proj.	2
Halifax, PA	Susquehanna River	Levee	No; B/C = 0.02
Hallstead, PA	Susquehanna River	Levee	No; B/C = 0.05
Harolds Run Area, PA	Susquehanna River	Levee	No; B/C = 0.15
Harrison Valley, PA	Cowanesque River	Levee	Yes; B/C = 1.0
Hartsville, NY	Purdy Creek	--	1
Hastings, PA	Chest Creek	--	1
Havre de Grace, MD	Susquehanna River	--	1
Hecton, PA	Susquehanna River	Levee	No; B/C = 0.42
Hemlock, PA	N. Br. Susq. River	Levee	1
Herndon, PA	Susquehanna River	Levee	No; B/C = 0.07
Highspire, PA	Susquehanna River	Levee & Channel Improvement	No; Low B/C ratio
Hinman Corners, NY	Chenango River	Levee	No; B/C = 0.40
Hollidaysburg, PA	Frankstown Branch	Levee	No; Low B/C ratio
Homer, NY	Tioughnioga River	Channel Imp.	No; B/C = 0.30
Hopewell, PA	Raystown Branch	Levee	No; B/C = 0.04
Hughesville, PA	Muncy Creek	Levee	1
Hornell, NY	Canisteo River	Exist. Corps' proj.	2
Horseheads, NY	Newtown Creek	Levee	No; B/C = 0.10
Huntington, PA	Juniata River	Exist. State Channel Improve. and Future Project	2
Hyde, PA	West Branch	Levee	No; Low B/C ratio
Ironville, PA	Juniata River	Levee & Floodwall	No; Low B/C ratio
Irvona, PA	Clearfield Creek	Exist. State LFP	1
Island Park, PA	West Branch	Levee	1

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluated Further?
Jermyn, PA	Lackawanna River	Levee	No; Low B/C ratio
Jersey Shore, PA	West Branch	Levee	No; B/C = 0.2
Johnson City, NY	Susquehanna River	Exist. Corps' proj.	2
Julius Rogers School Area, NY	Susquehanna River	Levee	No; B/C = 0.30
Kanona, NY	Cohocton River	Levee	No; B/C = 0.38
Keating, PA	Sinnemahoning Cr.	--	1
Killawog, NY	Tioghnioga River	Levee	No; Low B/C Ratio
Kistler, PA	Juniata River	Levee	No; B/C = 0.01
Knoxville, PA	Cowanesque River	Chan. improve.	No; B/C = 0.10
Lambs Creek, PA	Tioga River	Levee	No; B/C = 0.27
Lanesboro, PA	Susquehanna River	Levee	No; B/C = 0.02
Lawrenceville, PA	Tioga River	--	1
Lebanon, PA	Swatara Creek	Existing project	2
Lewisburg, PA	West Branch	Levee	No; B/C = 0.3
Lewistown, PA	Kishacaquillas Cr.	Levee, Floodwall, & Chan. Improve.	No; B/C = 0.07
Lindley, NY	Tioga River	Levee	No; B/C = 0.40
Linglestown, PA	Paxton Creek	--	1
Linkerville, PA	Susquehanna River	Levee	No; B/C = 0.04
Lisle, NY	Tioughnioga River	Exist. Corps' proj.	2
Liverpool, PA	Susquehanna River	Levee	No; B/C = 0.2
Lock Port, PA	West Branch	Levee	No; B/C = 0.2
Londonderry, PA	Susquehanna River	Levee	No; B/C = 0.2
Low. Swatara Twp., PA	Susquehanna River	--	1
Loyalsock Twp., PA	Susquehanna River	Corps proj. auth.	
Mahanoy City, PA	Mahoney Creek	--	1
Manhein, PA	Chickies Creek	Chan. Improve.	No; Low B/C's
Mansfield, PA	Tioga River	Proj. being constructed as part of T/H Lakes and Cowanesque Lake Projects.	
Mapleton Depot, PA	Juniata River	Floodwalls	No; B/C = 0.01
Marathon, NY	Tioughnioga River	Chan. Improve.	No; B/C = 0.34
Marrietta, PA	Susquehanna River	--	1
Marsh Run, PA	Susquehanna River	Levee	No; B/C = 0.02
Marysville, PA	Susquehanna River	Levee	No; B/C = 0.04
Mayfield, PA	Lackawanna River	Existing State	2

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further?
McGraw, NY	Trout Brook	Under SCS authority	---
McVettown, PA	Juniata River	Levee & Floodwalls	No; B/C = 0.01
Meshoppen, PA	N. Br. Susq. River	Levee	No; B/C = 0.07
Mexico, PA	Juniata River	Levee	No; B/C = 0.02
Middleburg, PA	Middle River	SCS Project	2
Middletown, PA	Swatara Creek	Levee & Floodwalls	No; B/C = 0.20
Mifflin, PA	Juniata River	Levee	No; B/C = .04
Mifflintown, PA	Juniata River	Levee	No; Low B/C
Milesburg, PA	Bald Eagle Creek	---	1
Mill Creek, PA	Juniata River	Levee	No; B/C = 0.26
Millersburg, PA	Wiconisco Creek	Levee	No; B/C = 0.04
Millerstown, PA	Juniata River	Levee	No; B/C = 0.02
Mill Hall, PA	Fishing Creek	Sec. 205 study underway	
Mocanaqua, PA	N. Br. Susq. Riv.	Levee	No; B/C = 0.3
Monroeton, PA	Towanda Creek	---	1
Montandon, PA	West Branch	Levee	No; B/C = 0.06
Montgomery, PA	West Branch	Levee	No; B/C = 0.3
Montoursville, PA	West Branch	Levee	No; B/C = 0.2
Moosic, PA	Lackawanna River	Existing St. LFP	2
Morris Run, PA	Tioga River	---	1
Mount Carmel, PA	Shamokin Creek	Chan. Improve.	No; B/C = 0.2
Mount Union, PA	Juniata River	Levee	No; B/C = 0.02
Mount Upton, NY	Unadilla River	Levee	No; B/C = 0.27
Muncy, PA	West Branch	Levee	Yes; B/C = 1.2
Myo Beach, PA	N. Br. Susq. River	Levee	No; B/C = 0.49
Nanticoke, PA	N. Br. Susq. River	Levee	No; B/C = 0.25
Nelson, PA	Cowanesque River	Community to be relocated as part of the Cowanesque Res. project.	
Nescopeck, PA	N. Br. Susq. River	Levee	No; B/C = 0.1
New Berlin, NY	Unadilla River	Channel improvement & levee	No; B/C = 0.01
Newberry, PA	West Branch	--	1
New Buffalo, PA	Susquehanna River	Levee	No; B/C = 0.32
New Columbia, PA	West Branch	Levee	No; B/C = 0.01
New Cumberland, PA	Susquehanna River	Levee & Floodwall	No; B/C = 0.20
New Market, PA	Susquehanna River	Levee	No; B/C = 0.06
Newport, PA	Juniata River	Levee & Floodwall	No; B/C = 0.23
Newton Hamilton, PA	Juniata River	Floodwalls & Chan. Imp.	No; B/C = 0.004

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further?
Nichols, NY	Susquehanna River	Exist. Corps' proj.	2
Nicholson, PA	Martins Creek	---	1
Ninvah, NY	Susquehanna River	Levee	No; B/C = 0.14
Norwich, NY	Chenango River	Exist. Corps' proj.	2
Oakdale, NY	Susquehanna River	Exist. SCS project	2
Olyphant, PA	Lackawanna River	Levee and channel	1
Oneonta, NY	Susquehanna River	Channel improvement	1
Osceola, PA	Cowanesque River	Channel improvement	No; B/C = 0.43
Ouaquaga, NY	Susquehanna River	Levee	No; B/C = 0.14
Owego, NY	Susquehanna River	Exist. Corps' proj.	3
Oxford, NY	Chenango River	Exist. Corps' proj.	2
Patton, PA	Chest Creek	Existing State LFP	2
Petersburg, PA	Shaver Creek	Levee	No; B/C = 0.47
Philipsburg, PA	Moshannon Creek	Existing State LFP	2
Plainsville, PA	N. Br. Susq. River	Levee	No; B/C = 0.20
Pokeville, NY	Tioughnioga River	Levee	No; B/C = 0.15
Poolville, NY	Sangerfield River	Levee	No; Low B/C
Poor House Run, PA	Codorus Creek	Levee	No; B/C = 0.3
Port Blanchard, PA	N. Br. Susq. River	Levee	No; B/C = 0.07
Port Crane, NY	Chenango River	Levee	No; B/C = 0.10
Port Dickson, NY	Chenango River	Channel Improve.	No; B/C = 0.22
Port Royal, PA	Juniata River	Levee	No; B/C = 0.09
Potter Brook, PA	Cowanesque River	---	1
Presho, NY	Tioga River	Levee	No; B/C = 0.40
Rathbone, NY	Canisteo River	Levee	1
Renovo, PA	West Branch	Levee	No; B/C = 0.1
Riddlesburg, PA	Raystown Branch	Levee	No; B/C = 0.05
Riverside, PA	N. Br. Susq. River	Levee	No; B/C = 0.20
Riverview, PA	West Branch	Levee	No; B/C = 0.1
Rockville, PA	Susquehanna River	Levees	No; B/C = 0.09
Ross Corners, NY	Tracey Creek	Levee	No; B/C = 0.08
Royalton, PA	Susquehanna River	Levee & Floodwall	No; B/C = 0.10
Savona, NY	Cohocton River	Levee	No; B/C = 0.15
Sayre, PA	Susquehanna River	Exist. State proj.	2
Schenevus, NY	Schenevus River	Chan. improvement & levee	
Scranton, PA	Lackawanna River	Channel	No; B/C = 0.34
Selinsgrove, PA	Susquehanna River	Levee & Floodwall	No; B/C = 0.12
Shady Nook, PA	Susquehanna River	Levee	No; B/C = 0 13

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further
Shamokin Dam, PA	Susquehanna River	Levee	No; B/C = 0.1
Sherburne, NY	Chenango River	Exist. Corps' proj.	2
Sherman Creek Area, PA	Susquehanna River	Levee	No; B/C = 0.31
Shickshinny, PA	N. Br. Susq. River	Levee	No; B/C = 0.11
Sidney, NY	Susquehanna River	Levee	No; Low B/C
Simpson, PA	Lackawanna River	Levee	No; B/C = 0.10
Skinners Eddy, PA	N. Br. Susq. River	Levee	No; B/C = 0.20
Smithfield Twp., PA	Juniata River	Exist. St. Project	2
Smithville, NY	Genegantslet Creek	Levee	No; B/C = .42
South Corning, NY	Chemung River	Levee	3
South Port, NY	Seely River	Levee	No; Low B/C
South Renovo, PA	West Branch	Levee	No; B/C = 0.01
Spangler, PA	Chest Creek	---	1
Steelton, PA	Susquehanna River	Levee	No; B/C = 0.29
Stillwater Rd. Area, NY	Susquehanna River	Levee	No; B/C = 0.05
St. Johns, PA	Nescopeck Creek	SCS Project	2
Susquehanna, PA	Susquehanna River	Chan. Improvement	No; Low B/C
Terry Town, PA	N. Br. Susq. River	Levee	No; B/C = 0.08
Tioga, PA	Tioga River	Exist. St. project	2
Tioga Center, NY	Susquehanna River	Levee	No; B/C = 0.10
Tipton, PA	Little Juniata Riv	Levee	No; B/C = 0.4
Towanda, PA	N. Br. Susq. River	Levee	No; B/C = 0.07
Truxton, NY	Tioughnioga River	Chan. Improve.	No; B/C = 0.20
Tunkhannock, PA	N. Br. Susq. River	Levee	1
Tuscarora Creek Area, NY	Tuscarora Creek	---	1
Tyrone, PA	Little Juniata Riv	Protection now being built	2
Unadilla, NY	Unadilla River	Exist. Corps' proj.	2
Union, NY	Patterson Creek	Exist. SCS project	2
Union Center, NY	Nanticoke Creek	Exist. SCS project	2
Vestal, NY	Susquehanna River	Exist. Corps' proj.	2
Wallace, NY	Cohocton River	Levee	No; B/C = 0.12
Watsontown, PA	West Branch	Levee	No; B/C = 0.3
Wellsboro, PA	Marsh Creek	---	1
Wellsburg, NY	Chemung River	---	Low Damage Poten.
West Corners, PA	Nanticoke Creek	Considered under SCS authority	--

TABLE 28 (con't)

RESULTS OF STRUCTURAL PROJECT EVALUATIONS

Community	Stream	Type of Project	Evaluate Further?
West Fairview, PA	Susquehanna River	Levee	No; B/C = 0.1
West Falls, PA	N. Br. Susq. River	Levee	No; B/C = 0.07
Westfield, PA	Cowanesque River	Chan. Improvement	Yes; B/C = 1.9
West Nanticoke, PA	N. Br. Susq. River	Levee	No; B/C = 0.10
Westover, NY	N. Br. Susq. River	Levee	No; B/C = 0.07
Westover, PA	Chest Creek	---	1
West Pittston, PA	N. Br. Susq. River	Levee	No; B/C = 0.35
Westport, PA	West Branch	Levee	No; B/C = 0.14
Whitney Point, NY	Tioughnioga River	Exist. Corps' proj.	2
Williamsburg, PA	Frankstown Branch	Levee & Floodwall	No; B/C = 0.43
Williamsport and S. Williamsport, PA	West Branch	Raise existing Corps' LFP	Yes; B/C = 0.9
Windsor, NY	Susquehanna River	Levee	No; B/C = 0.02
Winfield, PA	West Branch	Levee	No; B/C = 0.07
Wormleysburg, PA	Conodoguinet Cr.	Levee	No; B/C = 0.08
York, PA	Susquehanna River	Existing Project	2
York Haven, PA	Susquehanna River	---	1

1. No; Based on Engineering Judgement and/or recent changes in character of flood plain.

2. No; More protection is not justified.

3. Yes; Based on public interest and indications obtained from field visits.

TABLE 29

ECONOMIC RESULTS FOR COMMUNITIES CONSIDERED FOR FURTHER STUDY

Community	Type of Project	Annual Benefit	Annual Costs	BCR
Addison, NY	Extend Existing Projection	$20,500	$31,000	0.66
Binghamton, NY	Raise Existing Protection at "First Ward Area" (3')	$172,000	$155,000	1.10
Conklin - Kirkwood & Vicinity, NY	Channel Improvement	$607,900	$7,937,900	0.08
	New Levee and Floodwall	$645,400	$967,800	0.67
Endicott, NY	Raise Existing Protection (1')	$52,000	$76,000	0.70
	Raise Existing Protection (5')	$172,000	$291,000	0.60
Harrison Valley, NY	New Levee and Floodwall	$11,200	$54,900	0.20
	Channel Improvement	$6,400	$54,600	0.11
	Concrete Flume	$8,800	$80,200	0.11
Muncy, NY	New Levee and Floodwall	$1,143,000	$1,1921,700	0.59
Owego, NY	New Levee and Floodwall	$736,000	$1,230,000	0.60
South Corning, NY	Extend Existing Protection	$600	$1,150,000	0.003
Westfield, PA	Channel Improvement	$124,500	$164,900	0.75
Williamsport, PA	Raise Existing Protection	$1,200,000	$966,000	1.20

The main flood season for both rivers is in the late winter and early spring. Most of the higher floods have resulted from a combination of moderate snow, sudden thaw with consequent runoff of melt water, and heavy rains. However, floods due to intense thunderstorms, such as the July 1935 flood on the Chenango River, occur in the summer, and large floods may occur at any time.

The present protection system consists of approximately 6.5 miles of levees and floodwalls, one mile of improved channel, two upstream reservoirs, and appurtent interior drainage and closure structures. The existing features, except reservoirs, are shown on Figure 20 Although some damage occurs in low-lying unprotected areas, the largest potential damage centers are within the protected areas of Binghamton. If the existing system were overtopped, the effect would be devastating; the estimated minimum damage would be about $86,000,000, and there would be a significant threat of loss of life.

Plans of Improvement Considered: Since Binghamton already has an effective levee and floodwall system protecting the primary potential damage centers, the most practical alternative for increasing the level of protection is to raise and extend the existing system. Heights of floodwall and levee raisings up to the Standard Project Flood were analyzed for feasibility. It is estimated that the SPF along the Chenango and Susquehanna Rivers would overtop the existing protection, on the average, by 7 feet and 10 feet, respectively.

Basically, two height increases were considered at this level of study. The first included raising the protection up to a maximum of 3 feet. It was assumed that such a raise could be accomplished at a relatively modest cost. For height increases in this range, the additional clearance required along the existing levee and wall alignment is generally available, thus avoiding high costs in built-up areas for land acquisition and relocation of houses, utilities, railroads, and streets. Similarly, a height increase within this range would result in less costly design sections for levees and walls required to safely contain design capacities. In addition, pump station requirements, drainage facility modifications, and underseepage treatments would require less stringent design modifications, and thus costs, to adequately handle design flow capacities within a 3-foot raise. The second height increase considered involves increasing the height of protection greater than 3 feet. Based on site specific conditions at Binghamton, major structural modifications and/or replacements would be necessary. In addition, high costs associated with land acquisition and relocation of houses, utilities, railroads, and streets are likely to be realized.

Based on the above considerations and noting that most of the existing protection is adjacent to built-up areas, it appears that a maximum of 3 feet would probably be more favorable than higher schemes which would require major structural modifications or replacements. A study was performed for a 3-foot increase, not only because it is the maximum increase believed to be technically feasible, but also because it is the maximum in terms of practicality. Increases less than 3 feet would not lend themselves to economic construction due to the size and design of earthworking machinery.

As shown in Figure 20, the flood prone area of Binghamton was separated into four zones (First Ward, South Side, Center City, and North and East Sides) to aid in plan formulation. Solutions to provide additional protection were investigated by economically analyzing combinations of the above study areas. In addition to separate economic analysis of each area; complete protection, and protection against Chenango River flooding only were also investigated. The economic results of this analyses are indicated in Table 30.

Of the reaches adjacent to the Chenango River, i.e., the First Ward on the right bank and Center City and North and East Side on the left bank, raising the level of protection was determined to be economically feasible for the First Ward only.

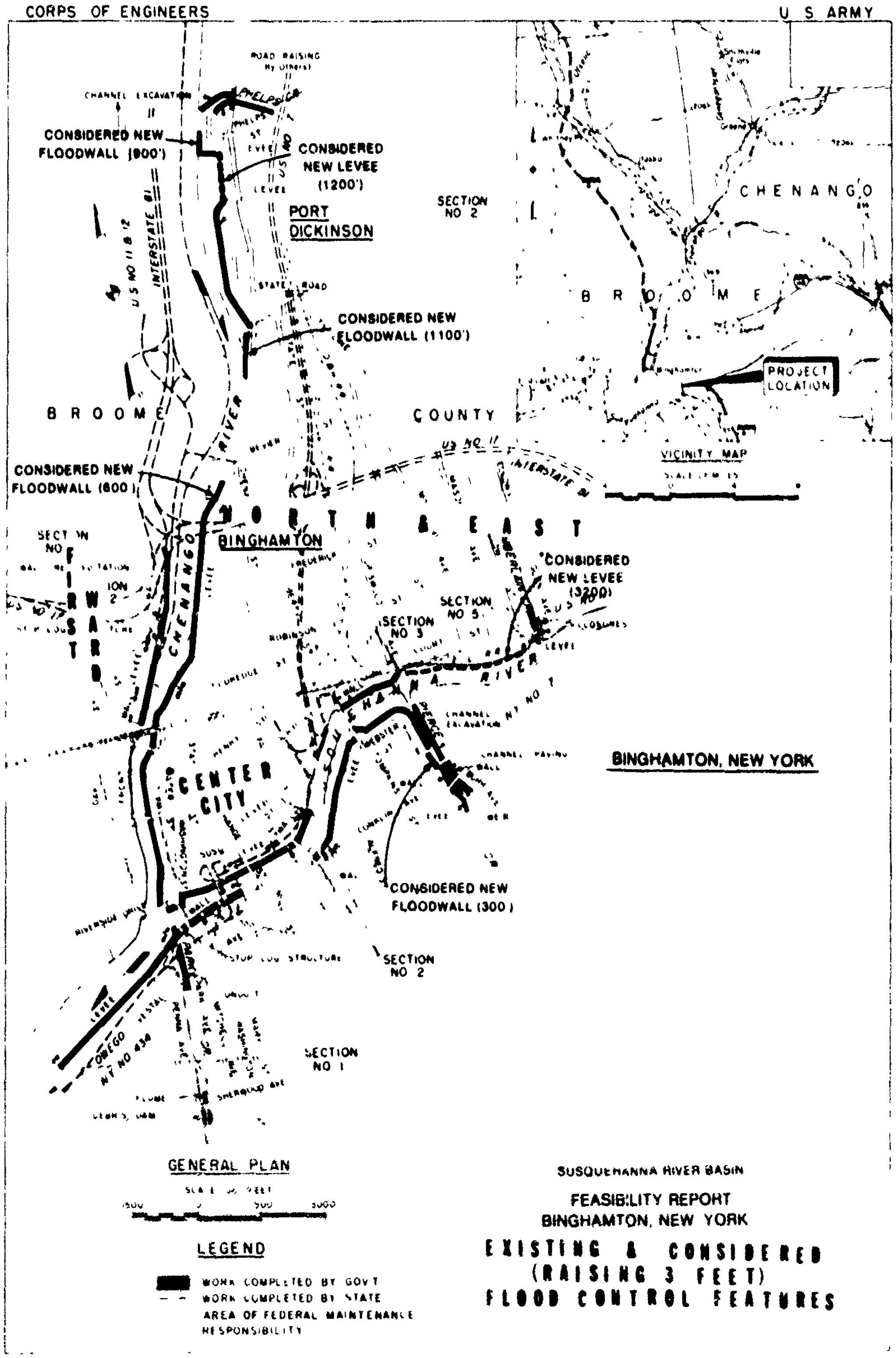

CORPS OF ENGINEERS
U S ARMY
CONSIDERED NEW FLOODWALL (800')
CONSIDERED NEW LEVEE (1200')
PORT DICKINSON
SECTION NO 2
CONSIDERED NEW FLOODWALL (1100')
BROOME COUNTY
CONSIDERED NEW FLOODWALL (600')
NORTH EAST
BINGHAMTON
CONSIDERED NEW LEVEE (3200)
SECTION NO 5
SECTION NO 3
CENTER CITY
BINGHAMTON, NEW YORK
CONSIDERED NEW FLOODWALL (300')
SECTION NO 2
SECTION NO 1
CHENANGO
BROOME
PROJECT LOCATION
VICINITY MAP
GENERAL PLAN
LEGEND
WORK COMPLETED BY GOV'T
WORK COMPLETED BY STATE
AREA OF FEDERAL MAINTENANCE RESPONSIBILITY
SUSQUEHANNA RIVER BASIN
FEASIBILITY REPORT
BINGHAMTON, NEW YORK
EXISTING & CONSIDERED (RAISING 3 FEET) FLOOD CONTROL FEATURES

Figure 20

There are no economically easible plans for raising the level of protection for all the reaches or any of the left bank reaches subject to Chenango flooding. Further analysis of the data indicated that, though the existing levels of protection on both banks of the Chenango River are similar, the left bank of the river effectively has no flood problem as defined by the computation of average annual damages. The estimated average annual damages from Chenango River flooding on the left bank are less than $200 at October 1978 prices. The clear implication of this data is that neither Center City nor North and East Side have a serious Chenango River flood problem. Therefore, elimination of potential flood damages in the First Ward is a comprehensive solution to Binghamton's Chenango River flood problem. The problem is economically feasible based on benefits to existing development.

The composite stage-damage curves for each of these zones represent an estimate of potential flood damages which would occur if floodwaters were to overtop the levees and reach the stages indicated. The primary difficulty with using this data to evaluate the feasibility of raising the protection along the Chenango River only is with the North and East area data. This area is in actuality subject to flooding from both the Susquehanna and the Chenango Rivers. Each of the flooding sources can act independently and cause damage to only a portion of the area. Not until very high flood stages does damage occur in the north area as a result of flooding from the Chenango River and similarly with the east area and the Susquehanna River. Because only one stage damage relationship is available representing damage to the entire area, it is not possible to determine the average annual damages which would result from flooding from each source which is necessary to evaluate raising the Chenango River protection only.

Plan Description: As indicated in Table 30 the most economically feasible plan identified in this reconnaissance level study consists of raising the protection along the right bank of the Chenango River portion of the existing flood protection system by 3 feet. This would include raising approximately 1,250 feet of levees and extending slope protection, modifying approximately 2,700 feet of floodwall by procedures other than "capping", adding approximately 100 feet of new floodwall, adding one new closure structure, extending existing closure structures, and acquisition of land needed for right-of-way requirements.

Costs: The cost summary and average annual cost of the proposed plan for a 3-foot increase in the level of protection, based on October 1978 prices, are given in Table 40. The average annual cost was computed using an interest rate of 6-7/8 percent for an economic life of 100 years. Interior drainage costs were not included as part of the total project costs. Drainage structures (inlet/outlet structures and control manholes) for the protection along the right bank Chenango River do not pass through or under the existing levee. Although passage through or under the existing floodwalls is realized, it was assumed for the purpose of this study, that the procedures to modify floodwalls would not affect existing drainage structures. In addition, it is expected that the increase in costs relating to possible pump station modifications will be a minor portion of the total project costs. As a result, it was assumed that the relatively high contingency percentage (25 percent) would account for added costs due to possible drainage structure modifications.

Benefits: Project benefits for this report are limited to flood damage reduction only. At October 1978 price levels, the average existing annual benefits for the proposed plan are $172,000. It is expected that existing development will continue to experience internal growth. Since the amount of flood damages is directly related to the value of a structure and its contents, it is reasonable to expect flood damages to increase along with increases in the value of residential, commercial, and industrial activities contents. Increases in inundation reduction benefits are expected to be directly proportional to increases in flood damages. Increases in the value of residential contents were calculated in accordance with the Corps' affluence factor methodology. Increases in the value of commercial and industrial contents

TABLE 30

PROJECT ECONOMICS BINGHAMTON, NEW YORK
(October 1978 Price Level)

	First Ward Protection	North and East Side Protection	Center City Protection	Southside Protection	Complete Protection	Chenango River Protection
FIRST COSTS						
Floodwalls	$990,000	$1,873,300	$2,090,000	$1,238,100	$6,012,700	$3,513,600
Levees	229,200	1,638,500	107,400	954,500	3,009,600	1,605,700
Closure Structures	179,000	239,000	30,500	51,700	347,500	170,200
Interior Drainage	—	76,200	15,900	75,500	167,700	62,400
Real Estate	3,200	37,700	4,300	23,500	68,700	40,900
Subtotal	$1,471,400	$3,864,700	$2,248,100	$2,353,800	$9,606,200	$5,392,800
Contingencies @ 25%	367,900	966,200	562,000	588,300	2,401,600	1,348,200
Subtotal	$1,839,000	$4,831,000	$2,810,000	$2,942,000	$12,008,000	$6,741,000
E&D and S&A @ 22%	404,600	1,063,000	618,000	647,000	2,642,000	1,483,000
TOTAL PROJECT COST	$2,224,000	$5,894,000	$3,428,000	$3,589,000	$14,650,000	$8,224,000
ANNUAL COSTS						
Interest and Amortization	$154,500	$406,000	$236,000	$247,000	$1,009,000	$566,000
Operation and Maintenance	1,000	7,000	1,000	4,000	13,000	7,000
TOTAL ANNUAL COSTS	$155,500	$413,000	$237,000	$251,000	$1,022,000	$573,000
ANNUAL BENEFIT	$172,000	$138,600	$300	$36,500	$347,500	$172,200
BCR	1.1	0.3	—	0.15	0.3	0.3

were calculated using a series of regression analyses for both commercial and industrial development. With benefits for future floodplain growth calculated to be $68,000, total inundation reduction benefits, both existing and future, are $240,000.

Justification: The results of these analyses, as presented in Table 40, indicate that the First Ward area has a benefit to cost ratio (BCR) greater than 1.0 to 1. The estimated annual benefits to this plan are $172,000 and the estimated costs are $155,500 at October 1978 prices for a BCR of 1.1 to 1. The total first cost has been estimated at $2,243,900 of which approximately $560,000 is currently estimated to be the local share.

Evaluated Accomplishments: The proposed plan for increasing the level of protection on the right bank of the Chenango River by 3 feet would reduce the damage potential within the existing protected area. In addition, the proposed improvement would raise the effective level of protection on the Chenango River from the present 180-year flood frequency level to approximately the 300-year flood frequency level. The proposed height increase could be completed in a relatively short period of time while maintaining continuous, effective flood protection during construction. Disruption of utilites and transportation facilities during construction would be minimal.

Effects on the Environment: The environmental effects of the proposed plan would be minimal. There should be no increase in river turbidity or other forms of water pollution since most of the construction would be in areas away from the water. Consequently, there would be no adverse effects on aquatic life. There are no known unique historic or geologic sites that would be disturbed during construction of the proposed plan. Because the plan consists of raising and extending the existing system, there would be no adverse effects on the aesthetics of the area. The proposed project would present the same visual impact as the existing system. There would be a temporary increase in noise and air pollution as a result of the construction activities.

A borrow area would probably be necessary to obtain the required quantity of fill for the levee embankment. The opening and working of a borrow area could have positive or negative effects on the environment, depending on its location and plan of operation.

Discussion: The evaluation performed for raising the level of the overall project has shown that it would not be economically justified. During the course of the evaluation, it became evident that, while the overall project was not justified, there was potential that increasing only the protection along the right bank of the Chenango River would be justified. Attempts to evaluate the feasibility of increasing only the Chenango River protection was frustated by inadequate available data. The most significant deficiency was with the damage data for the north and east side area which does not allow the evaluation of damages from either the Susquehanna or the Chenango River separately. In this study, the average annual damages for the north and east area were evaluated based on the effects of only the Susquehanna River flooding. Doing this results in a low estimate of the actual average annual damages and benefits because of the higher degree of protection provided against this flooding source.

From the analyses performed, it is apparent that further study of increasing the levee of protection along the right bank of the Chenango River is warranted.

b. Williamsport and South Williamsport, Pennsylvania

Location: Williamsport and South Williamsport are located in Lycoming County along the West Branch Susquehanna River about 40 miles upstream of its mouth. The drainage area at the center of Williamsport is 5,682 square miles, including the 262 square mile contribution of the

Lycoming Creek Basin. Based on the 1970 census, the combined population of Williamsport and South Williamsport is 45,071; this is approximately an 8 percent decrease from 1960.

Williamsport and South Williamsport are located in a natural east-west access route for transportation facilities through central Pennsylvania. The two major highways serving the metropolitan area are U.S. Routes 15 and 220. Rail service is provided by the Consolidated Rail Corporation (ConRail). In addition to well-developed residential portions, the Williamsport metropolitan area has a blend of light and heavy industry. Recent improvements to the highway system through the city have made the area more attractive for industrial development. Upstream of the Williamsport area, three-fourths of the Basin is uncleared. The flood plain averages about one mile in width, with much of the lowland along the river being farmed. The location is shown on Figure 21.

Flood Protection: Prior to completion of the existing system of protective works in 1955, Williamsport and South Williamsport were subject to frequent damaging floods, the largest of which occurred in March 1936. This flood produced a flow of approximately 264,000 cubic feet per second, and caused damages estimated at $10,600,000.

Since completion of the present system, which consists of 14 miles of levees and floodwalls, 10 pumping stations, 11 closure structures, appurtenant drainage structures, and 4 reservoirs on upstream tributaries, no significant damage from the West Branch has occurred within the protected areas. The existing project features are shown on Figure 24. The existing system provides protection against a flow of 264,000 cfs which can be expressed as an approximate 150-year frequency flood event. The June 1972 flood of record (FOR) rose to within one foot of the top of the existing system and produced a flow of 279,000 cfs. This flow was about 6 percent greater than the design capacity of the system. Although the system withstood the flood, the normal design freeboard was not available.

The primary flood season for the West Branch Susquehanna River is in the late winter and early spring. Many of the higher floods have resulted from a combination of moderate snow, sudden thaw with consequent runoff of melt water, and heavy rains. However, as evidenced by the June 1972 flood, which resulted from Tropical Storm Agnes rainfall, large floods may occur at any time.

Although some damage occurs in the unprotected areas, the largest potential damage centers are within the protected areas of Williamsport and South Williamsport.

If the existing system was overtopped, the effect would be devastating; the estimated minimum damage would be about $163,000,000. The recent trend of increased industrial development within the protected areas make the future damage potential even greater.

Plans of Improvement Considered: Since Williamsport presently has an effective and well-maintained levee and floodwall system protecting the primary potential damage centers, the most practical alternative for increasing the level of protection is to raise and extend the existing system. The practical height increase could be any amount up to 8 feet, which is approximately the level of the Standard Project Flood (SPF) for the area, as estimated in the flood plain information report completed in February 1971. The SPF is the largest flood that can be expected from the most severe combination of meterological and hydrological conditions considered characteristic of the area.

Within the 8-foot range of potential raising, two methods of increasing levee height were considered. It was assumed that small increases in height, e.g. up to a maximum of 3 feet, could be accomplished at relatively modest costs. For height increases in this range, the

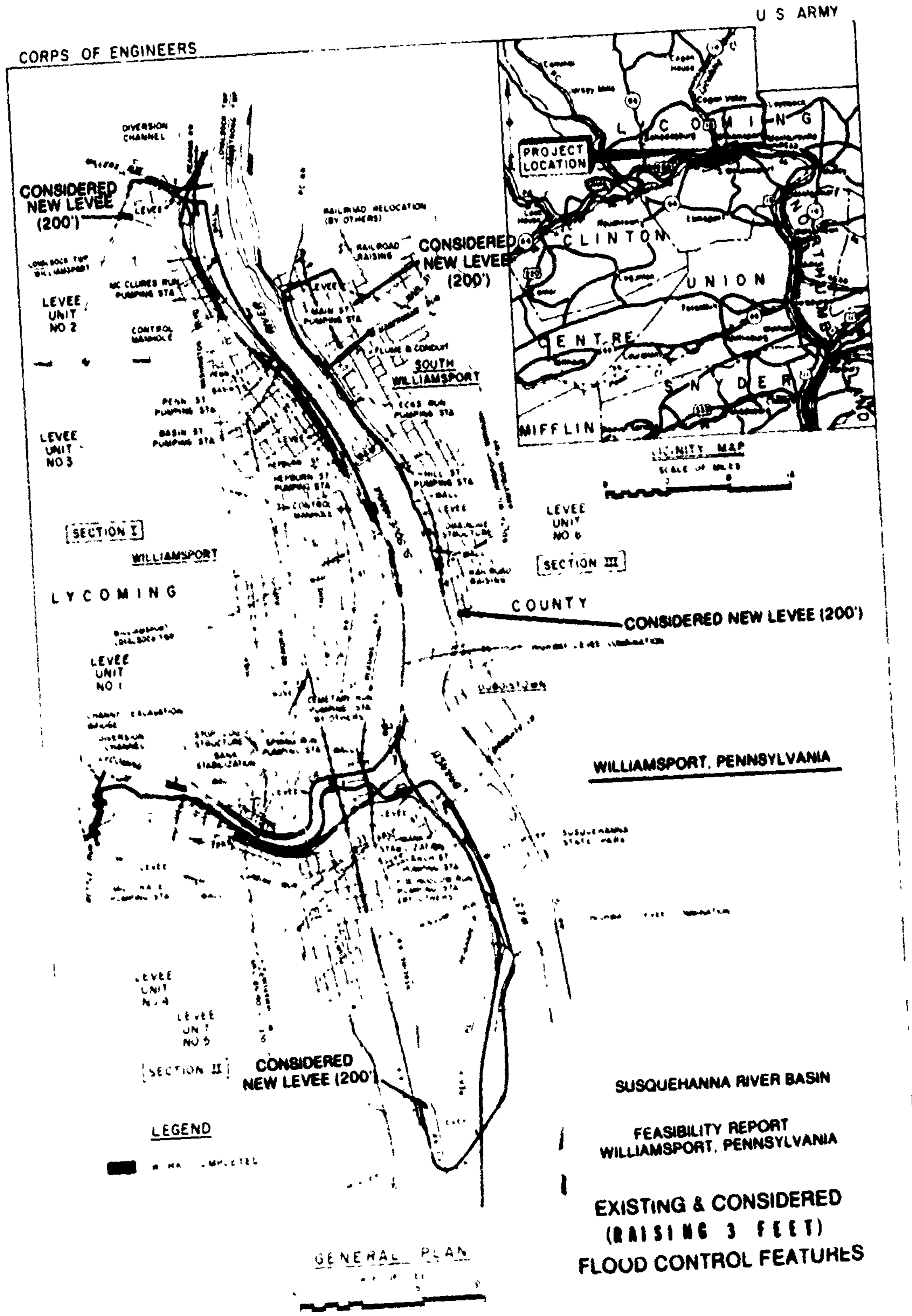

U S ARMY
CORPS OF ENGINEERS
CONSIDERED NEW LEVEE (200')
DIVERSION CHANNEL
LEVEE UNIT NO 2
MC CLURES RUN PUMPING STA
CONTROL MANHOLE
RAILROAD RELOCATION (BY OTHERS)
RAILROAD RAISING
CONSIDERED NEW LEVEE (200')
SOUTH WILLIAMSPORT
PENN ST PUMPING STA
BASIN ST PUMPING STA
LEVEE UNIT NO 3
HEPBURN ST PUMPING STA
LEVEE UNIT NO 6
SECTION I
SECTION III
WILLIAMSPORT
LYCOMING
COUNTY
CONSIDERED NEW LEVEE (200')
LEVEE UNIT NO 1
DUBOISTOWN
WILLIAMSPORT, PENNSYLVANIA
LEVEE UNIT NO 4
LEVEE UNIT NO 5
SECTION II
CONSIDERED NEW LEVEE (200')
LEGEND
PROJECT LOCATION
CLINTON
UNION
CENTRE
SNYDER
MIFFLIN
VICINITY MAP
SUSQUEHANNA RIVER BASIN
FEASIBILITY REPORT
WILLIAMSPORT, PENNSYLVANIA
EXISTING & CONSIDERED
(RAISING 3 FEET)
FLOOD CONTROL FEATURES
GENERAL PLAN

Figure 21

additional clearance required along the existing levee is generally available thus avoiding high costs in built-up areas for land acquisition and relocating houses, utilities, railroads, and streets. Similarily, a height increase in this range could be accomplished by less costly design sections for levees and walls required to safely contain design capacities. In addition, pump station requirements, drainage facility modifications and underseepage treatements would require less severe design modification, and thus less costly to adequately pass design flow capacities within a 3-foot raise. The second type of raising considered, involve height increases of more than 3 feet. Based on site specific conditions at Williamsport, major structural modifications and/or replacements would be necessary. In addition, high costs associated with land acquisition and relocation of houses, utilities, and streets are likely to be realized.

Based on the above considerations, two alternatives were studied. The first was to raise the level of protection by 3 feet, the second was to raise the protection by 6 feet. The 3-foot increase was considered primarily because it is the minimum practicable increase. The 6-foot increase was studied as representing an elevation indicative of economic justification for the upper ranges. Increases greater than 6 feet would result in much higher costs primarily because of clearance problems along the levees and much longer levee tie-outs. Also, benefits would not increase proportionally to the costs. As a result it became apparent that projects involving increases greater than 6 feet would probably not be economically justified.

Having eliminated schemes greater than 6 feet and less than 3 feet a comparison of the economics for the two schemes indicated that the 3-foot increase would be the best plan at the recommended level of evaluation.

Plan Description: As discussed above, the most feasible plan of increasing the level of protection consists of raising all portions of the existing systems by 3 feet. This includes raising approximately 62,700 feet of levee, extending 200 feet of floodwall, raising 3 existing closure structures, installling 22 new closure structures, modificatin of 41 inlet structures and 34 manholes, various utilitiy relocations, acquisition of 26 acres for right-of-way requirements, and acquisition of 2 residential structures.

There is sufficient clearance available along the existing levee to accomplish the height increase and the consequent increase in base width, but it cannot be accomplished all on one side. It would be necessary to transition back and forth between the landside and the riverside areas to avoid various features such as railroads, houses, utilities, and pumping stations. With the selected plan and a judicious choice of alignment, interference with such features would be minimal.

The proposed levee raising would consist of stripping off topsoil, adding embankment fill as needed, and reseeding the distrubed portions. Where slope protection is now in place to the top of the levee, it would be carried upward to the new top of levee. The current design freeboard would be established and included in the raising.

On the north bank of the West Branch Susquehanna River, from 3,600 feet upstream of the U.S. Route 15 bridge to Lycoming Creek, the new U.S. Routes 220 and 15 bypass are built atop the old levee. Although the highway was not designed to act as a levee, the existing highway-levee construction should be compatible with a 3-foot increase in levee height and the consequent potential 3-foot increase in water surface elevation. Where the highway embankment and levee are adjacent but independent, such as along the west bank of Lycoming Creek, raising the levee is a better solution than attempting to convert the higher highway embankment into a levee-type structure.

As part of this study, various procedures to raise existing "I" and "T" walls were investigated for engineering and economic applicability. These procedures consisted of placing butress supports behind wall; post-tensioning of the wall, addition of concrete sections, placing additional fill, installation of earth anchors towards the riverside, installation of an H-pile on the landside, installation of a semi-gravity section of landside, placing of an L-shaped wall in front or back of existing wall and replacing existing wall.

At this level of study, specific measures were not recommended for specific wall sections. Instead, representative costs for measures providing structural stability to the existing wall sections were utilized. Further, more detailed study would evaluate the most cost effective solution providing structural stability for each representative wall section.

For the 3-foot plan, the only new floodwall sections that would be required is at the Route 15 bridge piers on the levees, where short sections are recommended to facilitate compaction of levee materials to ensure that no leakage would occur at the piers.

At approximately 25 locations where streets and railroads intersect the levee and floodwall system, existing closures would have to be modified or new closures constructed to maintain continuity with the higher level of protection. Some of the closures could be ramp type but some must be structure type; detailed investigation of each location is required to determine which would be most economical.

Alteration of the interior drainage system would consist of modification of gate control structures, inlet structures, outlet structures, and pumping stations with the exception of the existing pumping stations, all interior drainage structures were categorized into "typical" classifications for cost analysis. The cost for these typical classifications were then used for the most similar drainage structure. Cost additions for possible modification to pumping stations were not included in our estimate, as this analysis would require detailed investigation appliable under further, more detailed studies.

It was assumed that a relatively high contingency percentage (25 percent) would account for added cost due to possible pump station modifications.

For the 3-foot plan, only two houses would be affected, both located in South Williamsport. At each end of the existing levee, some extension would be required, resulting in relocation of these houses.

Evaluated Accomplishments: The plan for increasing the level of protetion by 3 feet would not involve any long extensions of the existing system, and, consequently, would not significantly reduce the damage potential outside of the existing protected area.

The proposed improvement would raise the effective level of protection from the present 150-year frequency flood level to approximately the 300-year frequency flood level. Had the proposed increase been made prior to the June 1972 flood, satisfactory freeboard may have been available and the safety of the system ensured. The proposed height increase could be completed in a relatively short period of time while maintaining continuous, effective flood protection during construction. Disruption of utilities and transportation facilities during construction would be minimal.

Effects on the Environment: The environmental effects of the selected plan should be minimal. There should be no significant increases in river turbidity or other forms of water pollution since nearly all of the construction attempted to be performed would be landward of the existing levee. Consequently, there should be minimal adverse effects upon the aquatic

communities. Because the proposed plan provides only for a small extension of the existing system, it is not likely that any new unique historic or geologic sites would be distrubed, however this possibility would be investigated. For the same reason, there would not be any adverse effects on the aesthetics of the area. The proposed project would present the same visual impact as the existing system. There would be a temporary increase in noise and air pollution during the construction activities. Additional protection would create intangible benefits such as reduced risk to human lives and the enhanced feeling of security by the people in the study area.

A borrow area would be necessary to obtain the required quantity of fill for the levee embankment. The opening and working of a borrow area could have negative effects on the environment, depending on its location and plan of operation.

The proposed plan could be constructed with almost no disruption of utilities and transportation facilities, and it would have negligible adverse effects upon the human environment.

Costs: The cost summary and average annual cost of the plan for a 3-foot increase in the level of protection based on October 1978 prices, are presented in Table 31. Although the unit costs for the various items would be greater for this plan than higher ones, because smaller quantities for the same total lengths are involved, the plan avoids numerous and costly problems inherent in greater height increases.

The average annual cost was computed using an interest rate of 6-7/8 percent for an economic life of 100 years. The results of this analysis, as presented in Table 31, indicate that the associated total cost for raising the height of protection 3 feet is $14,000,000. The estimated non-Federal share is estimated to be $220,000, of which $80,000 would be incurred in South Williamsport and $140,000 in Williamsport.

Benefits: A September 1978 field inspection of the Williamsport flood plain with District and Division Corps personnel meeting with local officials and businessmen indicated an extremely high increase in the level of economic development since the District's last damage survey in the early 1960's. Over $80,000,000 in major structural development will have been built in the flood plain between 1960 and 1985. Revised stage-damage surveys will significantly increase average annual damages and potential benefits.

Though a reliable quantitative estimate of the increase in potential benefits is not available, a qualitative estimate, based on field observations, provides sufficient confidence to state the proposed plan will in all likelihood be economically feasible based on benefits to existing development. However, to facilitate an understanding of the expected economic feasibility of the project an "order of magnitude" estimate of benefits is made. The estimated market value of land and improvements in the flood plain at the time of the last damage survey (about 1963) was $117 6 million. Since that time, there has been a minimum increase of $80 million in new investment for an increase of about 70 percent. While recognizing the inaccuracies inherent in "order of magnitude" estimates, a 70 percent increase in potential flood damages, and therefore benefits, is nonetheless assumed for Williamsport. Benefits estimated from the outdated 1963 survey are $.7 million. To estimate the existing order of magnitude benefits, a 70 percent increase is assumed yeilding benefits of $1.2 million.

The results of this analysis indicate estimated annual benefits of $1.2 million, estimated annual costs of $.96 million and a benefit-cost ratio of 1.2.

Discussion: Using the average costs and benefits from the preceding paragraphs, the benefit-cost ratio for the 3-foot plan is 1.2.

TABLE 31

PROJECT ECONOMICS
WILLLIAMSPORT AND SOUTH WILLIAMSPORT, PENNSYLVANIA
(October 1978 Price Level)

Levee	Raise 62,700 L.F. of existing levee and extend 700 ft. of levee at an average combined cost of $801+/ L.F.	$ 5,253,000
Floodwall	Raise 4,550 L.F. of existing floodwall by 3 ft. (1,250 L.F. of "T" wall @ $645+/ L.F.) and construct 200 ft. of new wall @ $1301+/ L.F.	$ 1,973,000
Closure Structures	Raise 3 existing closures (average width = 40 ft.) by 3 ft. @ $7,000+/ each and construct 22 new closures (average width = 60 ft.) @ $68,8001+/ each.	$ 1,534,000
Interior Drainage	Modify 41 inlet structures @ $8,200 +/ each and 34 manholes @ $4,8001+/ each.	$ 502,000
Utility Relocations	Relocate 50 poles @ $4401+/ each	$ 22,000
Real Estate	Provide 26 acres additional right of way @ $2,700+/acre and acquire 2 structures @ $39,000 lump sum.	$ 128,000

SUBTOTAL	$ 9,412,000
Contingencies 25%+	2,353,000
SUBTOTAL	$11,765,000
E&D, S&A 15%+	1,765,000
TOTAL	$13,530,000
SAY	$14,000,000
ANNUAL COST	
Interest and Amortization (100 yrs @ 6-7/8%)	964,000
Operation and maintenance	2,000
TOTAL ANNUAL COSTS	$ 966,000
Annual Benefits	$ 1,200,000
BCR	1.2

Although the plan for a 3-foot increase does not significantly expand the system to presently unprotected areas, it does increase the level of protection from the present 150-year frequency flood level to about the 300-year frequency flood level. The present trend of continued industrial development within the protected areas would make this higher level of protection even more important in the future. From the analyses performed it is apparent that further study of increasing the level of protection in the Williamsport area is warranted.

Non-Structural Local Flood Protection

"Nonstructural" approaches to reducing the flood damages generally involve altering the flood susceptibility of individual structures rather than the traditional "structural" approaches which attempt to control the flood waters. Typical nonstructural solutions are flood proofing, acquisitions of properties, relocation of structures, raising of structures, and flood plain regulations.

Section 73 of the Water Resources Development Act of 1974 directed that any Federal agency involved in any aspect of flood protection should give consideration to non-structural alternatives to formulate the most economically, socially, and environmentally acceptable means of reducing or preventing flood damages. It also requires that non-Federal interests participate to the comparable value of the lands, easements, and rights-of-way required for structural protection, but not to exceed 20 percent of the project costs. With approximately 50,000 floodprone structures within the Susquehanna River Basin, an evaluation of the nonstructural alternatives was accomplished in three iterations, each of which was intended to identify those locations in the study area where non-structural alternatives would be feasible. The first iteration identified locations based on generalized screening criteria. The second iteration was a more detailed rescreening of all potential locations based on additional design and cost information and comments received from other agencies on the review of the first iteration. The third iteration was a refinement of the areas determined from the second iteration through a more detailed screening methodology and criteria process.

As a basis of the first iteration, a pilot non-structural study was performed for the community of Jersey Shore, Pennsylvania, for the purpose of developing a methodology for evaluating non-structural alternatives within the Susquehanna River Basin. This work is presented in a report by the Baltimore District titled "Evaluation of Non-Structural Flood Control Measures".

Based on the results and conclusions obtained from this pilot study a methodology was formulated based on the following considerations:

1. Economic considerations would be the primary screening tool for determining non-structural feasibilty.

2. The methodology to be utilized during the course of this study would involve a screening process where locations having the "highest potential" for reduction of flood damages would be considered for further analysis.

The screening process that evolved consisted of limitations on frequency of flooding of significant damages and the number of floodprone structures within a community. Based upon economic indications resulting from analysis of structures for Jersey Shore and results of other non-structural studies, it was felt that if significant damage within a community did not occur at least within the 15 year floodplain, economic justification would be lacking. It was also felt that those communities with fewer than 25 appraisals in the flood plain did not have a flood problem sufficiently serious to warrant a Federal project. The resulting screening process involved computation of benefits and costs for individual residential structures and collection of

data for non-residential structures where by future costs for floodproofing and relocation could be addressed.

Prior to evaluating the economics of the non-residential structures in the communities, it became apparent that the screening process was overlooking many floodprone structures which may have potential for economic justification. In addition, it became apparent that the cost figures were not representative of actual site conditions in many instances.

With the shortcomings of the initial screening analysis clearly identified, it was determined that a more reliable and comprehensive approach to determine non-structural economic feasibility within the Susquehanna River Basin was needed. Some of the objectives of this new approach were as follows:

1. Incorporate better costs information.

2. Incorporate better hydrologic information.

3. Identify all types of development, both residential and non-residential, which should be studied further.

The method incorporating all of the above objectives consists of economic evaluation of all flood-prone structures along the main stem and major tributaries of the Susquehanna River. Benefit to cost ratios for each non-structural measure were computed for all structures in the floodprone area. No predetermined screening critieria, such as that used in the first iteration, was used to eliminate areas for futher study. With this comprehensive approach decided upon, the next step was to improve the components of data affecting the economic analysis. These components generally consisted of descriptive data for structures, hydrologic data, and design and cost data.

Basic Data:

Descriptive Data for Structures: In the mid 1960's all of the residential, commercial, industrial, and public structures within the flood plain of the Susquehanna River and its major tributaries were inventoried. This information was originally intended for use in damage calculations to determine the feasibility of various structural projects. Within each area, each structure was identified by an appraisal number. In most cases mapping was constructed showing location of each appraisal. For a small number of communities, the flood plain was re-surveyed and corresponding information included as part of the current study. For each area the flood of reference was used as a datum. This flood of reference was the flood of record at the time of the survey for most communities, although the standard project flood was used in certain instances. In general, the survey included only those structures whose first floor was at or below the flood of reference plus 5 feet in elevation. Each residential appraisal was coded according to:

1. class of house, cabin, or trailer;

2. size (large, average, small);

3. furnishing (high, average, low);

4. basement (with or without);

5. style (1, 1-1/2, or 2 story);

6. flood conditions (backwater or seepage) (in some cases);

7. first floor referenced to the flood of reference;

8. zero-damage level referenced to the first floor; and

9. appraisal number.

Items that warrant further explanation are:

Item 1 warrantes further explanation. The houses are classified as either being - Class A, B, or C, where:

CLASS "A" - high valued homes

CLASS "B" - average valued homes

CLASS "C" - lower valued homes

The value of homes is dependent upon size and the price level of the residential structures within each of the communities.

Item 8 also warrants further explanation. Zero-damage level was the point at which damages would start. In some instances, unusual flood conditions (backwater or seepage) was incorporated. This lowered the zero-damage elevation for those structures with basements if it was estimated that the community, in general, had damage from backwater or seepage.

For each non-residential structure within the flood plain, the data consisted of the following:

1. for certain commercial structures the number of bays per garage, motel unit, etc.;

2. first-floor elevation referenced to the flood of reference;

3. zero-damage elevation referenced to the flood of reference;

4. flood condition (backwater or seepage) (in some cases)

5. type of business

6. first-floor area;

7. type of structure (store or garage);

8. with or without basement;

9. structural condition (good or poor); and

10. appraisal number.

These data served as the basic input to the non-structural evaluation and are very important to both benefit and cost determinations. Generally, it is felt the data are still representative of most actual field conditions that exist today. However, in certain areas the data could be questionable because of changed development in the flood plain.

Prior to initiation of the second iteration of the non-structural analysis, it was concluded that a complete basin-wide update of this descriptive information was not necessary to accomplish screening of all floodprone development. However, it was decided that during later stages of this analysis, a more refined data base would be needed to make accurate benefit and cost calculations for potentially feasible projects. Of particular importance was the need for structural data to enable preparation of better design information and cost estimates. This additional data collection effort consisted of a site visit to selected communities to gather information for utilization in both benefit and cost calculations. The items of information collected during this effort included verification of all 1960's vintage data and new data for structures not previously included. Other components of this more detailed data collection effort included:

1. Type of construction for both structure and foundation;

2. Market value of property;

3. Descriptive data whereby floodproofing cost items could be calculated for each non-residental structure; (i.e., Dimensions of openings)

4. First floor area;

5. Lot size;

6. Age of structure.

Hydrologic Data: During the early phases of the non-structural feasibility study it became apparent that some of the stage-discharge and discharge-frequency data were questionable. Therefore, an effort to obtain more reliable hydrologic information was undertaken. This is explained in the previous structural local flood protection section.

Design and Application of Feasible Nonstructural Measures: As a result of a preliminary analysis that was done to determine feasible nonstructural measures, certain nonstructural alternatives were defined to be applicable for structures within the Susquehanna River Basin areas. These measures along with their design features are listed in Table 32.

Table 32

DESIGN FEATURES - NON STRUCTURAL MEASURES

Nonstructural Measure	Features
1. Basement Floodproofing	Raising the house, removing the existing foundation, construction of a new reinforced concrete substructure with waterstops, temporary flood shields over doors and windows, check valves in the storm and sanitary lines, and landscaping.
2. Raising	Raising the house one to eight feet, removal of existing foundation, new foundation work and landscaping. New foundation includes: concrete footings, concrete masonry unit (CMU) walls, new flooring, painting, windows and doors, check valves, and removal and replacement of equipment.

Nonstructural Measures	Features
3. Acquisition and Demolition (Relocation of Owner)	Purchase value of land and house, structure demolition and site reclamation, resettlement fees, and acquisition expenses. Structural demolition and site reclamation includes disconnecting and capping all utilities, removal of material unsuitable for use as landfill, and the material required to backfill the foundation. The resettlement fee is the cost difference which will be realized between the market value of the present house and the value of comparable housing outside the flood plain. The acquisition expenses are the project costs associated with obtaining the properties, such as land survey, proper title search, and legal fees.
4. Relocation of Structure to a Non-Floodplain Site	House raising and moving, preparation of new foundation, and reclamation of the old site. New foundation work includes: excavation, backfill, concrete footings, CMU walls, damp-proofing, painting, gravel drain fill, concrete slab, windows, stairs, doors, and utility connections. If no utilites are present on the new site, a septic tank, well, and pump should also be included as part of this alternative. House raising and moving costs include disconnecting and capping all utilities at the present site and removal of obstructions enroute to the new location. Reclamation of the old site would include filling, grading and seeding.
5. Utility Cell	Provision of a 8' by 8' waterproof cell in the basement to protect basement utilities. Items associated with this alternative include: concrete, reinforcing, waterstop, watertight door, electrical work, relocation of equipment, and check valve.
6. Utility Addition	Construction of a new utility room or shed added onto the existing house at the first floor level. Items associated with the alternative include: excavation and back foundation, superstructure framing, siding and roofing, doors, windows, gutters and painting, electrical work, relocation of equipment, and check valve.
7. Raise and Basement Floodproof	Combining the measures of raising and basement floodproof.
8. Raise and Utility Addition	Combining the measure of raising and utility addition.
9. Commercial Floodproof	Composed of floodproofing the first floor and/or basement by building a floodwall or protecting the structure with floodshields, waterproofing the basement walls (if one exists), installing back flow valves in utility lines, and installing a sump pump with emergency generator in the structure.

Nonstructural Measures	Features
10. Do Nothing	Allow damages to occur.

For each fo the applicable nonstructural measures, a set of criteria was determined in applying these measures to each floodprone structure within the basin communities. These criteria are as follows:

1. Utility Addition (UA) - generally applies to Class "C" residential structures. The assumption is that the utilities are the bulk of basement damages for the various residential structures.

2. Acquisition and Demolition (A&D) - generally applies to class "C" residential structures and poor quality commercial structures experiencing a very severe flood problem. The location of the structure within the flood plain is a very important factor in the recommendation of this alternative.

3. Relocation of Structure (RS) - generally applicable to Class "A" and "B" residential structures. Based on the lack of structural integrity of Class "C" structures, it becomes more cost effective to acquire and demolish the structure than to relocate it. One should note that the depth of flooding above the first floor and location of the structure within the floodplain are important factors in recommendatin of this altenative. Generally this measure is not applicable to non-residential structures. However, there are exceptions for isolated structures in good condition, limited size, and experiencing severe flooding. This measure was the only one recommended for trailers due to the nature of their mobility.

4. Raising (R) - generally applicable to both residential and non-residential strutures in good condition, which are experiencing first floor flooding. Class "C" residential structures in poor condition and non-residential structures in poor condition and/or large size were not considered applicable for this measure.

5. Basement Floodproofing (BFP) - applies to structurally sound Class "A" and "B" residential structures, which experiences basement flooding only. The assumption was made that Class "A" and "B" residential structures typically have basements, in which the utilities are not the major portion of the damages and therefore protection of the complete basement is required. Based on structural consideration, floodproofing above the first floor was not considered applicable for residential structures.

6. Raising and Basement Floodproof (R&BFP) - same as the criteria set for raising with the exception that the structure has a basement.

7. Raising and Utility Addition (R&UA) - applies primarily to residential structures experiencing both basement and first floor flooding and where the major portion of basement damages are utilities. In some cases, this alternative may be recommended for non-residential structure of limited size whose major portion of the basement damages are also utilities.

8. Commercial Floodproofing (CFP) - generally applies to non-residential structures experiencing basement and/or first floor flooding. In some cases, townhouses and/or garden apartment type of structures may be recommended.

9. Do Nothing (DN) - applies to both residential and non-residential structures without a basement, which have a first floor flood problem but with little or no flood damage potential, e.g. open pavillions, fire stations, car washes, etc. This also applies to all landscape damages, transportation systems, etc.

Due to the cost of the utility cell alternative, it was later eliminated from consideration for the various flood prone structures.

Figure 22 shows the application of these nonstructural measures in relation to the various structural conditions.

Residential Structural Design and Cost Information: The costs which were utilized initially during this study for residential structures were representative of "average or typical" conditions within the Basin. These costs for the various measures were computed based on design computations involving many assumptions. It was determined that reliable cost information, representative of a cross section of structures typical of the Basin, should be developed and utilized during the revised nonstructural evaluation. Results of this effort are published in "Cost Report on Nonstructural Flood Damage Reduction Measures for Residential Buildings Within the Baltimore District" prepared by the Baltimore District and published as IWR (Institute for Water Resources) Pamphlet No. 4 July 1977. A summary of the costs for the measures used in this study is given below. All costs presented are at October 1977 price levels unless otherwise stated.

a. Basement floodproofing costs were derived by an individual cost estimate for a cross section of houses. Costs for this alternative ranged from $24,800 to $38,900, not including engineering and design and supervision and administration costs. It should be noted here that the major cost item is construction of a new foundation required to adequately support the structure should high water levels occur. The costs associated with a new foundation also expressed at October 1977 price levels ranged from $15,700 to $22,100. In the majority of reports concerning the subject of basement floodproofing, the conclusion is that this measure is only feasible for a sound structure, and even then to a very minimal flood height.

b. Raising costs were derived by individually estimating costs for a cross-section of structures. Cost curves were then compiled from this data. Structural variables that were included in compilation of the cost curves are as follows:

1. First floor area - 800 square feet to 1,600 square feet
2. Type of House
   - Slab on grade
   - Split level
   - 1 story with block foundation
   - 2 story with block foundation
   - 1 story with stone foundation
   - 2 story with stone foundation
3. Height of Raising - 1'4" to 8'0" (2-12 courses of concrete block)

Typical cost curves for raising the various house types are shown in IWR Pamphlet No. 4, pages 34-39. A range of costs is shown in Table 33. These costs do not include supervision and administration and engineering and design costs.

c. Cost for acquisition and demolition (relocation of owner) was based on purchase value of the land, market value of the house, structural demolition and site reclamation costs, resettlement fees, and acquisition expenses.


GOOD CONDITION
AVERAGE CONDITION
POOR CONDITION
CLASS A
CLASS B
CLASS C
LEGEND
Major First Floor Flooding
Minor First Floor Flooding
Basement Flooding
Relocation
Raise
Basement Floodproof
Do Nothing
Acquisition & Demolition
Utility Addition
Raise & BFP
A&D or Relocation
Basement

Figure 22

Average unit cost of land for the various class residential structures was determined to be \$.23/square foot based on land values (no improvements) in the flood plain of the following communities:

Lock Haven, Pennsylvania	\$.40/square foot
Alexandria, Pennsylvania	\$.10/square foot
Sidney, New York	\$.20/square foot

This value of \$.23/square foot translated into a land value range of \$2800 to \$3900 per property assuming class "A" structures have an average of 1/3 acre and class "B" and "C" structures having 1/4 acre of land.

The variables utilized for determination of the market value of the house include type of home, structural composition, foundation construction, location, quality of construction, condition of house, size of house, and age. These values are further described in the IWR Pamphlet.

Market value determinations are calculated by obtaining an initial market value of a house based on the type, structural composition, and foundation of the house. This range, as actually defined in Sidney, New York, Alexandria, Pennsylvania, and Lock Haven, Pennsylvania, typically fell between \$1,900 to \$37,900. The final market value of the structures was obtained by multiplying the initial market value by a factor, as determined by the location, quality of construction, condition, size and age of the house. Other cost items for this alternative include structural demolition and site reclamation cost (\$750 to \$1,350), resettlement fee (\$3,800 to \$5,950) and acquisition expense (\$3,250).

To incorporate the cost data into our analysis, it was necessary to combine the information into an average cost per structure, depending on the class of structure. Results were shown in Table 33.

d. Cost for physical relocation of the structure was based upon actual relocation costs, land costs at existing or relocated sites (whichever is larger), site improvement costs, disconnection and removal costs, and utility costs.

Actual relocation costs are dependent upon type of house and first floor area. Curves showing this information are shown on page 25 of the IWR Cost Report. Unit costs for land purchase are identical to those described for the acquisition and demolition alternative. Typical site improvement costs of \$1,000 for landscaping items were included. Cost for disconnections and removals are estimated to be \$1,500 per service interruption of overhead transmission lines, \$250 per intersection for service interruption of overhead traffic signals, and \$400 per large tree removal.

For the purposes of this study and based on typical conditions within the study area, it was assumed that two service interruptions of overhead transmission lines, two interruptions of overhead traffic signals and two large trees would be removed per structure. This totaled \$4,300.

The assumption was made that public utilities would not be available at the proposed site, which is typically the situation within the Susquehanna River Basin. An additional \$2,700 was added to the total costs for this alternative. This included a 1,000 gallon septic tank at \$500, drilling a 100 foot well at \$800, and a 250-770 gallons per hour well pump at \$1,400.

TABLE 33

RANGE OF COSTS FOR VARIOUS NONSTRUCTURAL ALTERNATIVES

COSTS FOR RAISING

	8 FEET	6 FEET	4 FEET	2 FEET
Class A				
	$22,400 - $26,100	$19,900 - $23,100	$17,200 - $20,000	$14,700 - $17,100
Class B				
	$20,800 - $21,100	$18,200 - $18,700	$15,800 - $16,200	$13,200 - $13,900
Class C				
	$17,800 - $20,000	$15,500 - $17,500	$13,200 - $15,300	$11,000 - $13,000

ACQUISITION AND DEMOLITION OF STRUCTURE

Class	Costs
A	$41,200
B	$39,500
C	$38,400

RELOCATION OF STRUCTURE

SIZE	CLASS A	CLASS B	CLASS C
Small	29,700 - 30,400	23,400 - 24,600	22,000 - 26,000
Average	32,900 - 33,700	26,800 - 27,500	24,000 - 28,900
Large	35,900 - 36,800	30,300 - 30,600	26,100 - 32,200

COSTS FOR UTILITY ROOM ADDITION AT FIRST FLOOR LEVEL

ITEM	
Excavation and Backfill	$ 220
Foundation	1,100
Superstructure Framing, Siding and Roofing	1,600
Doors, Windows, Gutters & Painting	1,190
Electrical Work	330
Relocaton of Equipment	1,100
Check Valve	760
Total	$6,300

Totaling the above described costs and expressing them based upon class of structure, first floor size, and 1 or 2 story construction, the values shown in Table 33 were constructed and utilized during the study.

e. The concept of utilizing a utility addition to the existing structure at the first floor level to store utilities normally found in basements was also investigated. Cost breakdown for such an addition was shown in Table 33.

Based on the relatively low costs of $6,300 and higher degree of protection, this option was applied to all residential structures within the Susquehanna River Basin for this study. It should be noted that this estimate is based on the assumption that the mechanical and electrical equipment are susceptive to relocation as was the case for the typical structures evaluated. In some instances, it may be necessary to permit the inundation of that equipment which cannot be relocated. Replacement of such equipment with furnishings compatible to the existing fixtures may be feasible. However, such costs are not included in this estimate.

Non-Residential Structures: Of the nonstructural measures, consisting of floodproofing, raising, utility room addition, relocation of structure, and relocation through acquisition and demolition, only floodproofing and relocation through acquisition were considered applicable for non-residential structures. Raising of the structure to a height above the design flood for the non-residential structures within the Susquehanna River Basin generally was not considered economically feasible, since many of these structures have large first floor areas, thus increasing both the difficulty in physically raising the structure and costs. Other problems associated with the raising alternative for non-residential structures involve access and aesthetic problems. It should be noted that some of the commercial buildings within the Susquehanna River Basin are actually converted residential buildings. Should further study be warranted for a particular location, raising of these structures would be addressed at that time. The utility cell option was not considered for these structures. In most cases, the proportion of damages resulting from basement utilities is very minimal, compared to the damage attributable to both the structure and inventory, thus resulting in low economic justification. Physical relocation of the structure itself was also determined to be impractical for the majority of non-residential structures within the study area. The physical size of many commercial/industrial structures precludes moving; also many of them are connected in block-long units which makes moving more difficult. Increased costs for utility hook-ups, disconnection and removal of obstructions enroute to the new site, and raising costs in most cases were of the magnitude to prevent economic justification.

Assuming that non-residential structures are structurally sound, floodproofing consists of covering openings with aluminum floodshields to provide a waterproof cover. Also included is covering the basement walls with a waterproof seal, installing a backflow check valve, and providing a sump pump. For those structures that did not have either poured concrete or concrete block walls, it was assumed that a frame would be required around each opening to provide a proper seal for the floodshields. The shields could extend up to six feet above the first floor elevation. Table 34 present the costs for floodshields, with and without frames for various size openings at September 1976 price levels. To these costs were added the following:

1. $0.75 per square foot of wall area (below 6 feet above the first floor and including the basement walls) for waterproofing.

2. $500 for backflow valves.

3. $1,000 per 1,000 square feet for a sump system. A minimum of $1,000 was used with an additional $1,000 for any part of each 1,000 square feet additional. These costs would include an emergency generator to power the pumps but do not provide for special storage for gasoline, which could be required for safety reasons. Where the structure was shared by a number of enterprises, the costs were apportioned equally.

Acquisition and demolition costs for commercial structures were based on actual site visits for seven communities. In these communities, market value (including land values) for each non-residential structure was calculated. These values were based on recent sales within the communities and obtained from the real estate brokers within these typical communities. In addition, average acquisition expenses of $4,000 and resettlement costs of $5,800 were added to the market value of the property to determine the total costs for acquisition and demolition of each structure.

Preliminary Nonstructural Analysis:

Residential Methodology: With approximately 50,000 residential floodprone structures for which data were available it was essential that computer computation of benefit-cost ratios (BCR's) for these structures be utilized. Initial estimates of BCR's determined during this second iteration incorporated classification data collected during the 1960's, stage frequency data, stage-damage data, and cost data as determined by averaging curves presented in IWR Pamplet No. 4. Amortization and interest charges were based on 6-5/8 percent interest rate and 50 year project life. No maintenance costs were included for any of the nonstructural measures. Twenty-five percent was used for contingencies and 15 percent was used for engineering design, supervision, and administration.

A computer program was used to calculate average annual flood damages prevented (benefits), annual costs and the resulting BCR's for each structure for each measure as described previously. Economic benefits were determined for the raising alternative by first computing average annual damages for the structure as it presently exists. Modified average annual damages were then calculated for each measure. Average annual benefits were then computed as the difference in annual damages before and after the modification.

Existing average annual damages were directly credited as benefits for both relocation options (relocation of structure and relocation of occupants). Average annual benefits for the utility room addition option were computed as the difference in average annual damages before and after the modification. A percentage of damages below the first floor level, representing the damage potential of the utilities was shifted to a level above the first floor. Average annual damages were then computed for the modified structure and benefits derived by subtracting the two average annual damage figures.

As mentioned previously, a computer program was used to compute benefit-cost ratios for each residential structure within the flood prone area in the Susquehanna River Basin. For each appraisal, seven benefit-cost ratios were computed (raising 2, 4, 6, and 8 feet, relocation of structure; relocation of occupants; i.e., acquisition and demolition and utility room addition). The maximum benefit-cost ratio as well as the class of house and the type of nonstructural measure giving the maximum benefit-cost ratio was indicated on computer printout forms. For each community, a summary of the community statistics and stage-frequency values were also printed. Subsequent to compiling this list of all communities with at least one residential structure with a justified BCR, communities were grouped into regional areas which appeared to

TABLE 34

FLOOD SHIELD COSTS

Width of Flood Shield (feet)	Height of Flood Shield (feet)	Area (S.F.)	Flood Shield Cost per Sq. Ft.	Flood Shield Cost	Sealing Frame Length (L.F.)	Sealing Frame Cost per L.F.	Sealing Frame Cost	Storage & Installation Length (L.F.)	Storage & Installation Cost per L.F.	Storage & Installation Cost	Vertical Supports Number	Vertical Supports Cost Each	Vertical Supports Cost	Total Cost w/Sealing Frame	Total Cost Without Sealing Frame
10	2.0	20	$32	$ 640	14	$25	$350	10	$10	$100	0	$118	0	$1090	$740
10	3.0	30	$32	$ 960	16	$25	$400	10	$30	$300	0	$148	0	$1660	$1,260
10	4.0	40	$32	$1280	18	$25	$450	10	$50	$500	0	$178	0	$2230	$1,780
10	5.0	50	$32	$1600	20	$25	$500	10	$60	$600	0	$208	0	$2700	$2,200
10	6.0	60	$32	$1920	22	$25	$550	10	$70	$700	0	$238	0	$3170	$2,620
20	2.0	40	$32	$1280	24	$25	$600	20	$10	$200	1	$118	118	$2198	$1578
20	3.0	60	$32	$1920	26	$25	$650	20	$30	$600	1	$148	148	$3318	$2668
20	4.0	80	$32	$2560	28	$25	$700	20	$50	$1000	1	$178	178	$4438	$3738
20	5.0	100	$32	$3200	30	$25	$750	20	$60	$1200	1	$208	208	$5358	$4608
20	6.0	120	$32	$3840	32	$25	$800	20	$70	$1400	1	$238	238	$6278	$5478
30	2.0	60	$32	$1920	34	$25	$850	30	$10	$300	2	$118	236	$3306	$2456
30	3.0	90	$32	$2880	36	$25	$900	30	$30	$900	2	$148	296	$4976	$4076
30	4.0	120	$32	$3840	38	$25	$950	30	$50	$1500	2	$178	356	$6646	$5696
30	5.0	150	$32	$4800	40	$25	$1000	30	$60	$1800	2	$208	416	$8016	$7016
30	6.0	180	$32	$5760	42	$25	$1050	30	$70	$2100	2	$238	476	$9386	$8336
50	2.0	100	$32	$3200	54	$25	$1350	50	$10	$500	4	$118	472	$5522	$4172
50	3.0	150	$32	$4800	56	$25	$1400	50	$30	$1500	4	$148	592	$8292	$6892
50	4.0	200	$32	$6400	58	$25	$1450	50	$50	$2500	4	$178	712	$11062	$9612
50	5.0	250	$32	$8000	60	$25	$1500	50	$60	$3000	4	$208	832	$13332	$11832
50	6.0	300	$32	$9600	62	$25	$1550	50	$70	$3500	4	$238	952	$15602	$14052
100	2.0	200	$32	$6400	104	$25	$2600	100	$10	$1000	9	$118	1062	$11062	$8462
100	3.0	300	$32	$9600	106	$25	$2650	100	$30	$3000	9	$148	1332	$16582	$13932
100	4.0	400	$32	$12800	108	$25	$2700	100	$50	$5000	9	$178	1602	$22102	$19402
100	5.0	500	$32	$16000	110	$25	$2750	100	$60	$6000	9	$208	1872	$26622	$23872
100	6.0	600	$32	$19200	112	$25	$2800	100	$70	$7000	9	$238	2142	$31142	$28342
300	2.0	600	$32	$19200	304	$25	$7600	300	$10	$3000	29	$118	3422	$33222	$25622
300	3.0	900	$32	$28800	306	$25	$7650	300	$30	$9000	29	$148	4292	$49742	$42092
300	4.0	1200	$32	$38400	308	$25	$7700	300	$50	$15000	29	$178	5162	$66262	$58562
300	5.0	1500	$32	$48000	310	$25	$7750	300	$60	$18000	29	$208	6032	$79782	$72032
300	6.0	1800	$32	$57600	312	$25	$7800	300	$70	$21000	29	$238	6902	$93302	$85502

be potential projects. Grouping was performed in anticipation that nonstructural project recommendation would be made for regional areas. It was felt that a field trip to a representative sample of communities within these regional areas would be appropriate to more accurately represent site specific conditions. The data which were collected as part of this field trip consisted of:

1. The type of foundation for the structures.

2. The condition of the structures.

3. A preliminary assessment of the sociological and environmental impacts of a nonstructural project on the community.

4. Any impediments to a nonstructural project on the community.

5. Generalized condition of the flood problem.

6. New stage-damage survey update information.

The vast majority of the residential structures observed during the field inspection were of wood frame construction, constructed prior to 1950, and generally well maintained. About 50 percent had foundations constructed of concrete block and the remaining had brick or fieldstone.

Based on the results obtained during the field trip, a further refinement of costs for some of the nonstructural measures was necessary. Some of the variables affecting the costs associated with raising, relocation of structure, and relocation of owner are as follows:

1. Age

2. Has the structure been remodeled?

3. Would a 10 percent cost reduction be applicable based on group implementation of nonstructural alternatives?

4. Type of house. (frame, brick)

5. Would temporary housing costs be applicable?

6. Availability of utility hook-ups.

7. Market values of properties.

The revised cost information as indicated in Table 35 was then incorporated into the computer program to replace cost values used prior to the field trip. The costs were obtained from IWR Pamphlet No. 4 and modified to incorporate site specific conditions. Results of this analysis and subsequent grouping is shown on Table 36, which indicates revised information.

Non-Residential Methodology: Because of the large number of non-residential structures within the Susquehanna River Basin and based on the relatively small data base, as compared to that of residential structures it was decided that an economic evaluation for these structures be based upon a generalized approach. Although generalized, it was felt that the results of this type of

TABLE 35

REVISED NONSTRUCTURAL ALTERNATIVE COSTS

Nonstructural Measure					Costs
Utility Cell Addition					$6,300
Raising		8'	6'	[illegible]	2'
	Class A	$18,500 - 27,000	16,900 - 24,700	13,300 - 21,800	9,900 - 19,500
	Class B	$16,800 - 24,900	15,000 - 23,300	11,400 - 20,300	7,400 - 18,200
	Class C	$14,600 - 23,100	13,000 - 21,500	9,800 - 18,700	8,800 - 16,800
Relocation of Structure	Size	Class A	Class B	Class C	
	Small	$29,900 - 30,600	$24,300 - 28,100	$19,100 - 23,100	
	Average	$33,100 - 33,900	$24,600 - 27,600	$21,100 - 26,000	
	Large	$36,100 - 37,000	$27,600 - 31,200	$23,200 - 29,200	
Relocation of Owner		Class A	Class B	Class C	
		$24,900 - $48,700	$21,700 - $42,200	$19,200 - $36,800	

NOTE: Costs do not include engineering and design and supervision and administration costs.

TABLE 36

NONSTRUCTURAL RESIDENTIAL SCREENING RESULTS

River Name	Community Name	State	Number of residential structures with benefit-cost ratios greater than 1.0
North Branch Susquehanna River	Oneonta	NY	1
	Sidney	NY	2
	Unadilla	NY	82
	Rural N-7	NY - PA	4
	Conklin Station	NY	4
	Julius Rogers School Area	NY	28
	Rural N-8	NY	6
	Stillwater	NY	12
	Conklin	NY	27
	Kirkwood	NY	13
	Rural N-13	NY	22
	Fairmount Park	NY	8
	Owego	NY	4
	Tioga Center	NY	1
	Rural N-15	NY	2
	Cannon Hole	NY	9
	Rural N-17	NY	10
Unadilla River	Mt. Upton	NY	5
	New Berlin	NY	4
	S. New Berlin	NY	2
	Rural U-1	NY	2
	Rural U-2	NY	1
Chenango River	Norwich	NY	6
	Rural CN-5	NY	3
	Chenango Forks	NY	4
	Rural CN-6	NY	8
	Port Crane	NY	2
	Broad Acres	NY	33
	Rural	NY	1
	Greene	NY	3
Tioghnioga River	Cortland	NY	50
	Pokeville	NY	4
	Killawog	NY	6
	Marathon	NY	53
Cohocton River	Savona	NY	1
	Coopers Plain	NY	20
	Rural Co-3	NY	38
	Campbell	NY	2

TABLE 36 (con't)

NONSTRUCTURAL RESIDENTIAL RESULTS

River Name	Community Name	State	Number of residential structures with benefit-cost ratios greater than 1.0
Cowanesque River	Potter Brook	PA	13
	Westfield	PA	60
	Oceola	PA	10
	Harrison Valley	PA	2
	Knoxville	PA	10
West Branch Susquehanna River	Curwensville	PA	3
	Hyde	PA	1
	Clearfield	PA	4
	Renovo	PA	9
	Rural W-8	PA	22
	Rural W-14	PA	2
	Muncy	PA	6
	Lewisburg	PA	6
	Island Park	PA	1
Bald Eagle Creek	Mill Hall	PA	6
	Flemington	PA	1
	Rural W-BE-1	PA	8
Susquehanna River	2 mil Dwnstrm. Clarks Ferry	PA	2
	Rural S-9	PA	11
	West Fairview Township	PA	1
	Royalton	PA	2
	Middletown	PA	2
	New Cumberland	PA	2
	Rural S-3	PA	1
	Duncan Island	PA	3
	Selinsgrove	PA	12
Juniata River and Branches	Bedford	PA	1
	Williamsburg	PA	11
	Alexandria	PA	18
	Rural J-F	PA	12
	Mill Creek	PA	1
North Branch Susquehanna River	West Nanticoke	PA	2
	Shickshinny	PA	2
	Bloomburg	PA	1

evaluation would be valid if an adequate representative sample of communities within the Susquehanna River Basin could be identified for which detailed non-residential data were available.

Detailed non-residential data were available for seven communities and served as basic input to the analysis. Within these communities, data for 187 structures were available. One hundred seventy structures had data for floodshield analysis, and 109 had data for acquisition analysis. Thirty-eight percent of the structures analyzed for flood shields had benefit-cost ratios greater than 1.0. Fifteen percent of the structures analyzed for acquisition had benefit-cost ratios greater than 1.0. Various correlations were attempted between a level and frequency of flooding and benefit-cost ratio. The relationships with the highest correlation factors was a log-log plot of frequency of flooding of the zero-damage level versus benefit-cost ratio for floodshields. The coefficient of correlation was 0.92. A similar plot for the benefit-cost ratio for acquisition and demolition had a correlation coefficient of 0.90. The above analysis included all structures except vacant buildings. In all the analyses, the spread of data was so great that definitive results could not be obtained. An attempt was made to categorize certain structures and obtain plots with less data spread. However, the results were not significantly better than those originally obtained. These results could be used for initial surveys of a community. If the level of flooding that yields a benefit-cost ratio of 1.0 were plotted within the community, then the number of buildings within the flooded section would be indicative of the number of buildings that would have a benefit-cost ratio greater than 1.0. For the communities with a large number of non-residential structures, the number of justified structures would be more accurate.

Once these data were analyzed it was determined that if the zero damage elevation for non-residential structures was below the 8 year flood plain for floodproofing or the 3 year flood plain for relocation, there was a possibility of economic justification.

Utilizing the computer, a listing of the number of "possibly justified" non-residential structures was obtained for each flood prone area. Within each area, a representative sample of structures was evaluated to obtain average annual damages. Based on the known order of magnitude of the first costs for these nonstructural measures, it was possible to determine, based on engineering judgement, if these measures would be economically justified. The results of this determination are shown in Table 37.

<u>Prelimanary Screening Results:</u> A nonstructural project, to be socially acceptable to a community, would be on either a neighborhood or community basis. In this regard, those structures with favorable benefit-cost ratios would be combined with adjacent structures that do not have favorable benefit-cost ratios, and one overall benefit-cost ratio would be computed for the entire project. Therefore, the number of structures with favorable benefit-cost ratios, the numerical value of these ratios, as well as the location of the structures, with respect to each other, are important in determining the feasibility of a nonstructural project in a community. The best nonstructural project will not necessarily be the one that has the highest net benefits. It will be the one that reduces damages by the greatest extent while still being economically feasible and socially acceptable.

Preliminary screening involved determining if a community had at least one justified structure. A justified structure is defined as one that has a benefit-cost ratio greater or equal to 1.0 for at least one of the various nonstructural measures considered. It was apparent that a feasible project could not be formulated for each community. The main consideration in establishing screening criteria was whether or not a nonstructural project would be economically justified. Another consideration was whether or not a nonstructural project would substantially alleviate a community's flooding problem. Based on these considerations, criteria

were established to screen each community. If the community did not meet the criteria, then its relationship with contiguous communities was examined. In some cases regional areas, consisting of a number of proximate communities with justified structures, warranted further study while some of the individual communities within the area did not.

For a community to remain under consideration it had to contain a minimum of 20 justified structures. Since project formulation would probably require that adjacent unjustified structures in a neighborhood also be included in a proposed nonstructural plan, it would be impossible to include very many and still have an economically feasible project. Even if the justified structures were in isolated pockets within the community, the administrative and design costs for such a small number of structures would far exceed the amounts previously assumed and could approach the construction costs. Nonstructural measures applied to these few justified structures would not substantially lessen flood damages in each community. Should any of the communities particularly request that nonstructural measure be applied to these structures a project might be feasible at a non-federal level. It was not feasible to include these communities in a regional area warranting further study. These communities are listed in Table 38.

Communities in which the percentage of justified structures was low are also listed in Table 38. Although the communities might have sufficient structures to formulate a feasible nonstructural project, the low percentage indicates that measures applied to these structures alone would not substantially lessen a community's flooding problem. The only community in this category was a rural reach which extended along several miles of stream. Project formulation in this reach would be on a structure by structure basis. Design and administrative costs would be higher than were assumed for this area. It was not practicable to include this community in a regional area warranting further study.

The locations which had justified structures and were not screened out using these criteria were retained for further study. The location of these communities and areas is shown on Figure 23. Pertinent data is presented in Table 39. The following paragraphs are a discussion of each of the communities and areas recommended for further study and includes specific information on the feasibility of a nonstructural project in that location.

Unadilla, N. Y.: Unadilla is a community located along the Susquehanna River between Oneonta and Sidney. The town is primarily residential with one light manufacturing enterprise and some commercial establishments. In Unadilla there are many houses in the low-lying area along the right bank of the Susquehanna River that are subjected to frequent flooding. No recent development in the flood plain was noted during the field visit. In the final analysis for this community, an average house was assumed to be frame construction, single story with concrete block foundation. This was typical for the majority of houses observed during the field visit. Residents that were interviewed expressed concern about flooding. This community was recommended for further study because of the density and large number of justified houses and because of the community's interest in flood protection measures.

Coopers Plain, N. Y.: Coopers Plain is a community in a substantially rural area lying along the left bank of the Cohocton River within the Town of Erwins and west of Painted Post. The community is situated upstream of the confluence with Meads Creek. Just downstream of Coopers Plains is a large number of houses originally classified in a rural area. Between these two areas is a new development of Long Acres. The area, for the purposes of this study, is considered one community and has been included in Table 39. Portions of the community are low-lying and are flooded frequently. It is significant to note that the nonstructural analysis was based on flooding from the Cohocton River only. If the effects of flooding from Meads Creek were also considered, it is probable that the number of justified houses would increase. The average house used to compute costs was an average of new, average size structures and

TABLE 37

NONSTRUCTURAL NON-RESIDENTIAL SCREENING RESULTS

River Name	Community Name	State	Number of non-residential structures with benefit-cost ratios greater than 1.0
North Branch Susquehanna River	Oneonta	NY	5
	Sidney	NY	5
	Unadilla	NY	3
	Center Village	NY	3
	Ninevah	NY	2
	Lanesboro	PA	2
	Rural N-7	NY - PA	3
	Conklin Station	NY	2
	Julius Rogers School Area	NY	3
	Rural N-8	NY	4
	Conklin	NY	2
	Kirkwood	NY	4
	Rural N-13	NY	1
	Fairmount Park	NY	1
	Owego	NY	1
	Rural N-17	NY	1
Unadilla River	Mt. Upton	NY	3
	New Berlin	NY	1
	Rural U-1	NY	1
	Rural U-2	NY	1
Chenango River	Chenango Forks	NY	5
	Greene	NY	3
	Brisban	NY	1
Tioghnioga River	Cortland	NY	5
	Killawog	NY	1
	Marathon	NY	22
Cohocton River	Savona	NY	3
	Kanona	NY	1
	Coopers Plain	NY	1
	Rural Co-3	NY	8
	Campbell	NY	3
Cowanesque River	Academy Corners	PA	3
	Potter Brook	PA	5
	Westfield	PA	27
	Oceola	PA	6
	Knoxville	PA	3

TABLE 37 (con't)

NONSTRUCTURAL NON-RESIDENTIAL SCREENING RESULTS

River Name	Community Name	State	Number of non-residential structures with benefit-cost ratios greater than 1.0
West Branch Susquehann River	Curwensville	PA	1
	Clearfield	PA	12
	Riverview	PA	1
	Renovo	PA	12
	Rural W-8	PA	2
	Westport	PA	1
	Rural W-10	PA	1
	Muncy	PA	6
	Lewisburg	PA	2
	Island Park	PA	1
	Rural W-12	PA	4
	Jersey Shore	PA	4
	Duboistown	PA	1
	Milton	PA	10
	Rural W-20	PA	10
Susquehanna River	2 mil Dwnstrm. Clarks Ferry	PA	13
	Middletown	PA	1
	New Cumberland	PA	5
	Rural S-3	PA	9
	Duncan Island	PA	3
	Marietta	PA	10
	Selinsgrove	PA	4
Bald Eagle Creek	Mill Creek	PA	34
Juniata River and Branches	Rural J-B	PA	5
	Williamsburg	PA	21
	Alexandria	PA	13
	Rural J-F	PA	1
	Rural J-9	PA	8
	Lewistown	PA	8
	Rural J-11	PA	3
North Branch Susquehanna River	Rural N-22	PA	4
	Rural N-23	PA	1
	Rural N-24	PA	3
	Tunkhannock	PA	1
	West Nanticoke	PA	3
	Plainsville	PA	3
	Shickshinny	PA	1
	Bloomsburg	PA	1

TABLE 38

COMMUNITIES NOT CONSIDERED FOR FURTHER NONSTRUCTURAL STUDY

(Communities with few Justified Structures)

Community and State	Number of Justified Structures
Oneonta, N.Y.	6
Sidney, N.Y.	7
Ouaguaga, N.Y.	2
Rural Area N-7	7
Mt. Upton, N.Y.	8
New Berlin, N.Y.	5
South New Berlin, N.Y.	2
Rural Areas Along Unadilla River, N.Y.	5
Rural Area CN-5	7
Norwich, N.Y.	6
Chenango Forks, N.Y.	7
Greene, N.Y.	6
Brisben, N.Y.	1
Savona, N.Y.	4
Curwensville, PA	4
Hyde, PA	1
Clearfield, PA	16
Rural Area, W-14	2
Muncy, PA	12
Lewisburg, PA	8
Island Park, PA	2
Downstream of Clarks Ferry, PA	15
Selinsgrove	16
West Fairview Township, PA	1
Royalton, PA	2
Middletown, PA	3
New Cumberland, PA	7
Rural Area, S-3	10
Duncan Island	6
Bedford, PA	1
Mill Creek, PA	1
West Nanticoke, PA	5
Shickshinny, PA	3
Bloomsburg, PA	2

(Communities in Which the Percent of Justified Structures was Low)

Community	Number of Structures	Total Number of Structures in Flood Plain	Percentage of Justified Structures in Flood Plain
Renovo, PA	21	814	3.0%
Rural Area Near Renovo, PA	24	227	10.6%

TOTAL NUMBER OF JUSTIFIED STRUCTURES NOT RECOMMENDED FOR FUTHER STUDY = 235

the older, larger structures. This represents a fair composity of the community and figures presented in Table 39 should be accurate. This community was considered for further study because of the large number of justified houses, the density of those houses, and the possibility of further damage from tributaries.

Regional Area A: This area is comprised of communities located along the Susquehanna River and the Chenango River in Broome and Tioga Counties. The center of the area is the Binghamton - Endicott - Johnson City urban complex, which has major flood protection works designed by the Corps of Engineers. The area has experienced a fair amount of suburban growth, some of which is in low-lying areas. Portions of the area were visited in the field, and damage areas in most communities are clusters of homes at various locations along the river banks. This area was considered for further study because of the large number of justified houses and the local interest in flood protection.

Regional Area B: This area is comprised of communities along the Cowanesque River in Pennsylvania between the western boundary of Tioga County and Elkland. Communities along the river are farming communities, although there are a few commercial enterprises in some of the larger communities. Westfield is the largest of these, and a Section 205 reconnaissance report for structural flood protection was completed for the community. The structures along the rural reaches are relatively high above the flood plain and, with the application of nonstructural measure to the communities, the flooding damages would be significantly reduced for the entire reach. The area was considered for further study because of the large number of justified houses and the local interest in the flood problem. Pertinent figures are presented in Table 39.

Regional Area C: This area consists of communities in Pennsylvania along the Frankstown Branch of the Juniata River and along the Juniata River between the Frankstown Branch and Huntingdon. The area was not visited during the field trip and a conclusive opinion of the feasibility of nonstructural measures was not obtained. However, the two towns in this area are local commercial centers. From knowledge of the area, the houses are probably older two story frame structures. New development is probably mininal as the towns are similar to others in the area. It was considered for further study because of the number of justified houses. Pertinent figures were presented in Table 39.

Regional Area D: This area is comprised of communities along the Tioughnioga River in New York between Cortland, N. Y. and Lisle, N. Y. The area is essentially rural and the smaller towns are farming communities. Houses in the area are old but are in generally good condition, except in Marathon, where the condition is fair. Application of nonstructural measures to this area would alleviate the major flood damage along the entire reach. This area was considered for further study because of the large number of justified houses localized in the four communities listed in Table 39.

Upper Watersheds Analysis: The nonstructural evaluations described in the earlier portion of this section addressed only those flood prone areas traditionally included in Corps' studies. This included all areas along the main stem of the Susquehanna River and its major tributaries.

There are a large number of flood prone communities in the basin which are not within the Corps' study area. The U.S. Department of Agriculture Soil Conservation Service (SCS) under the authority of the Watershed Protection Act (PL 89-566) has the responsibility of addressing flood problems and needs in the rural upper watersheds of the basin. To ensure that the total study area was addressed adequately the SCS was requested to review the flood prone communities in the upper watershed and identify those which appear to have potential for nonstructural projects.

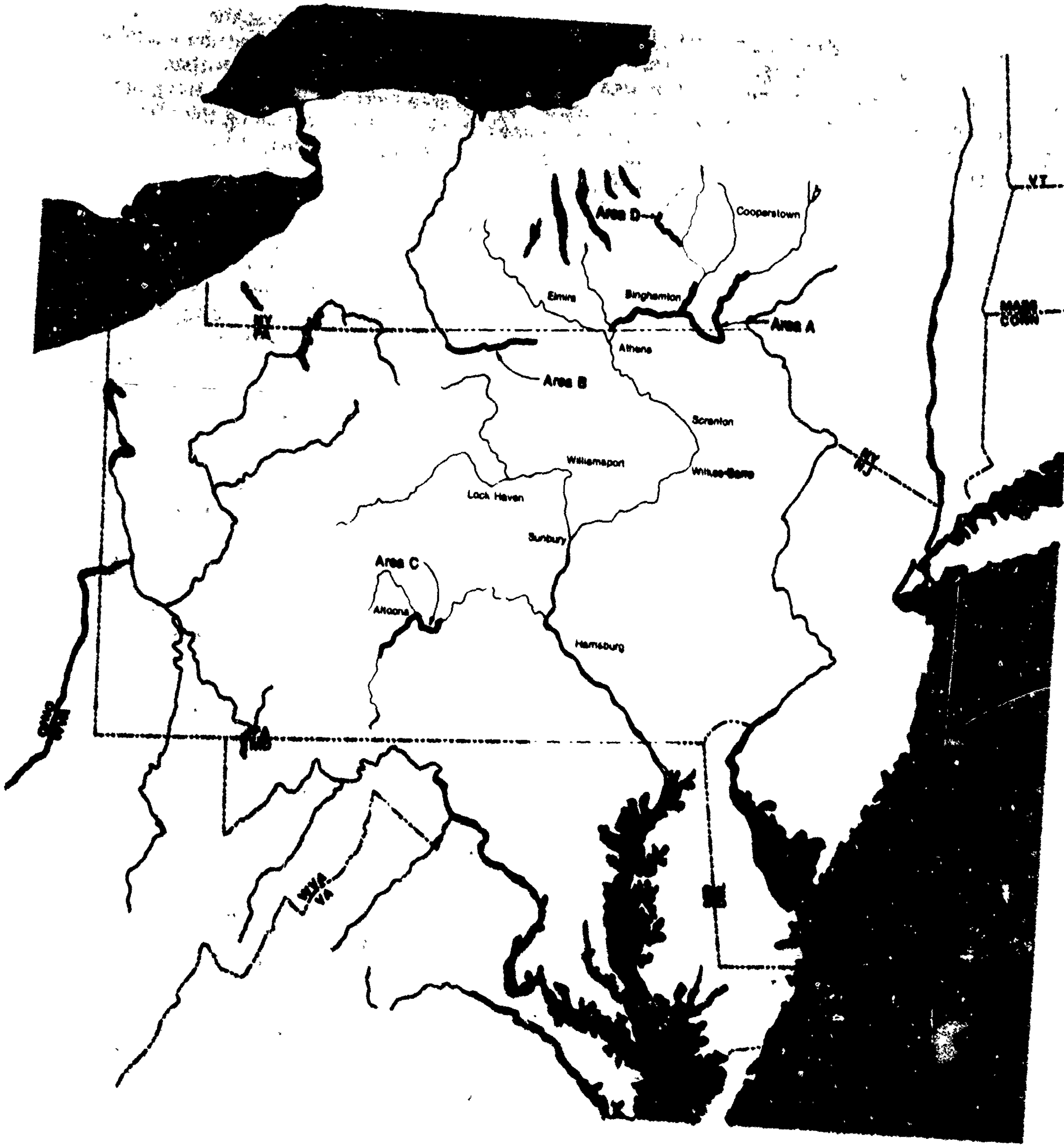

Cooperstown
Area D
Elmira
Binghamton
Area A
Athens
Area B
Scranton
Williamsport
Wilkes-Barre
Lock Haven
Sunbury
Area C
Altoona
Harrisburg
V.T.
MASS
CONN

Figure 23

Table 39

COMMUNITIES AND REGIONAL AREAS CONSIDERED FOR FURTHER STUDY

REGIONAL AREA	RIVER NAME	COMMUNITY AND STATE NAME	TOTAL NUMBER OF HOUSES WITHIN FLOOD PLAIN	COMMUNITY AVERAGE BENEFIT-COST RATIO FOR JUSTIFIED HOUSES (3)	TOTAL NUMBER OF JUSTIFIED HOUSES	TOTAL NUMBER OF JUSTIFIED NONRESIDENTIAL STRUCTURES (1)	TOTAL NUMBER OF JUSTIFIED STRUCTURES (1)
-	North Branch Susquehanna River	Unadilla, N.Y.	250	1.56	82	3	85
-	Cohocton River	Coopers Plain, N.Y. (2)	364	1.52	58	9	67
A	North Branch Susquehanna River	Conklin Sta., N.Y.	13	1.18	4	2	6
		Julius Rodgers Area, N.Y.	132	1.50	28	3	31
	"	Rural, N.Y.	44	1.49	6	11	17
	"	Stillwater, N.Y.	55	1.72	12	0	12
	"	Conklin, N.Y.	357	1.35	27	2	29
	"	Kirkwood, N.Y.	103	2.31	13	4	17
	"	Rural, N.Y.	244	3.20	22	1	23
	"	Fairmount Park, N.Y.	64	1.39	8	1	9
	"	Owego, N.Y.	392	1.21	4	1	5
	"	Tioga Center, N.Y.	28	1.08	1	0	1
	"	Rural, N.Y.	45	1.41	2	0	2
	"	Cannon Hole, N.Y.	30	1.45	9	0	9
	"	Rural, N.Y.	72	1.73	10	1	11
	Chenango River	Rural, N.Y.	107	1.76	8	0	8
	"	Port Crane, N.Y.	36	1.33	2	0	2
	"	Broadacres, N.Y.	129	2.06	33	0	33
	"	Rural, N.Y.	56	1.17	1	0	1
		TOTALS FOR AREA:	1907	1.84	190	26	216

Table 39 (cont)

COMMUNITIES AND REGIONAL AREAS CONSIDERED FOR FURTHER STUDY

REGIONAL AREA	RIVER NAME	COMMUNITY AND STATE NAME	TOTAL NUMBER OF HOUSES WITHIN FLOOD PLAIN	COMMUNITY AVERAGE BENEFIT-COST RATIO FOR JUSTIFIED HOUSES (3)	TOTAL NUMBER OF JUSTIFIED HOUSES	TOTAL NUMBER OF JUSTIFIED NONRESIDENTIAL STRUCTURES (1)	TOTAL NUMBER OF JUSTIFIED STRUCTURES (1)
B	Cowanesque River	Potter Brook, Pa.	33	2.82	13	5	18
	"	Westfield, Pa.	138	4.36	60	27	87
	"	Oceola, Pa.	31	2.84	10	6	16
	"	Harrison Valley, Pa.	24	1.48	7	0	7
	"	Knoxville, Pa.	137	1.33	10	8	18
		TOTALS FOR AREA	363	3.65	100	46	146
C	Juniata River and Branches	Williamsburg, Pa.	93	2.06	10	18	28
		Alexandria, Pa.	159	1.42	18	13	31
		Rural, Pa.	40	2.58	12	1	13
		TOTALS FOR AREA	292	1.54	40	32	72
D	Tioghnioga River	Cortland	357	2.19	50	5	55
		Pokeville	18	1.70	4	0	4
	"	Killawog	18	1.30	6	1	7
	"	Marathon	77	1.69	53	22	75
		TOTALS FOR AREA:	470	1.89	113	28	141
		TOTALS FOR TABLE:	3646	2.07	583	144	727

NOTES: (1) These figures not used as criteria in selecting communities
(2) Includes contiguous rural area
(3) Computed by averaging the maximum benefit-cost ratio for each house.

The SCS used existing flood damage data as a base for this review. A literature search was made of river basin studies, the Appalachian studies, PL-566 applications, emergency flood disaster reports, and data assembled by the Commonwealth of Pennsylvania and the State of New York. The SCS review is limited to communities with contributing drainage area of 250,000 acres or less. Flood insurance studies were used where available to assess damage areas. Communities with large numbers of residences and/or businesses damaged were identified. Those communities in the basin with at least $5,000,000 of residential and/or $1 million of commercial damage were also identified. The listings were then compared and a master list prepared. A map study using 7 1/2 minute quadrangle sheets was made of communities with high damages. Those communities with wide flood plains and, therefore, relatively shallow flooding were selected for "onsite" examination. Residential areas where a 100-year storm event was judged to flood to a depth of three feet or less were considered good prospects for "nonstructural" flood damage reduction measures. Industrial-commercial facilities were considered good prospects if located in ares of moderate - less than 6 feet - flooding depths from the 100-year event.

Table 40 lists the communities reviewed by the SCS and presents the results of the analysis of the potential for nonstructural flood damage reduction.

Detailed Screening Process: As a result of the preliminary nonstructural analysis, six areas were defined to have potential for flood reduction by nonstructural alternatives. These were shown on Figure 23. The six areas were screened again to determine which communities would benefit from a nonstructural approach to reducing its flood problem. Three criteria were applied to this evaluation.

The first criteria assumes that it is in the Federal interest to consider nonstructural measures only in areas that would reasonably be considered for structural protection. This insures that development is sufficiently concentrated to permit the development of a community plan rather than dealing with widely scattered properties. The second criteria requires that at least 20 percent of the community's structures be floodprone. Again, it is in the Federal interest to consider communities which have a severe flooding problem. The third criteria is closely related to the first, in considering only those areas where development is concentrated. A minimum of ten structures must be in close proximity to each other, such as within a block to satisfy this criterion.

Based on this evaluation which applied these three criteria, nine communities were identified for further study. They were Westfield, Pennsylvania, and Coopers Plain, Julius Rodgers School Area, Conklin-Kirkwood, Broadacres, Marathon, Cortland, and Unadilla, New York, which are shown on Figure 24. Subsequent investigation revealed that Cortland and Westfield did not suffer significant flood damages and they were not evaluated further.

Development of Community Plans: Prior to the development of community plans, an updated field survey was made consisting of an update of the existing conditions for all the floodprone structures including a detailed flood damage analysis of the nonresidential structures, and obtaining a photograph for each structure. The additional field data was incorporated into the detailed nonstructural analysis.

Plan formulation utilized an interdisciplinary team approach, which considered the technical, environmental, and economic aspects in developing nonstructural plans. For each of the remaining communities under consideration, the flood problem was identified for various levels of protection by determining the number of structures which received flood damage based on a comparison of the structure's position relative to level of protection under consideration. A wide range of levels of protection was considered including both frequent and infrequent floods.

TABLE 40

Communities in Upper Watersheds Having Potential for Nonstructural Alternatives

COMMUNITY	POTENTIAL
Pennsylvania	
Thompsontown	Moderate
Hollidaysburg	Moderate
Altoona	Moderate
Inner-city area between Hollidaysburg and Altoona	High
Carlisle	Very High
Spring Grove	Low
Montoursville	Moderate
Monroeton	High
Trout Run	Moderate to High
Ralston	High
Mill Hall	Very High
Mifflinburg	High
Shomskin	Low
Lancaster	Low
York	Moderate
Hershey	Moderate
Hummelstown	Moderate
New York	
Bath	Moderate
Coopers Plains	Moderate
Owego	Moderate
Elmira	Moderate
Marathon	Moderate
McGraw	High
New Berlin	High

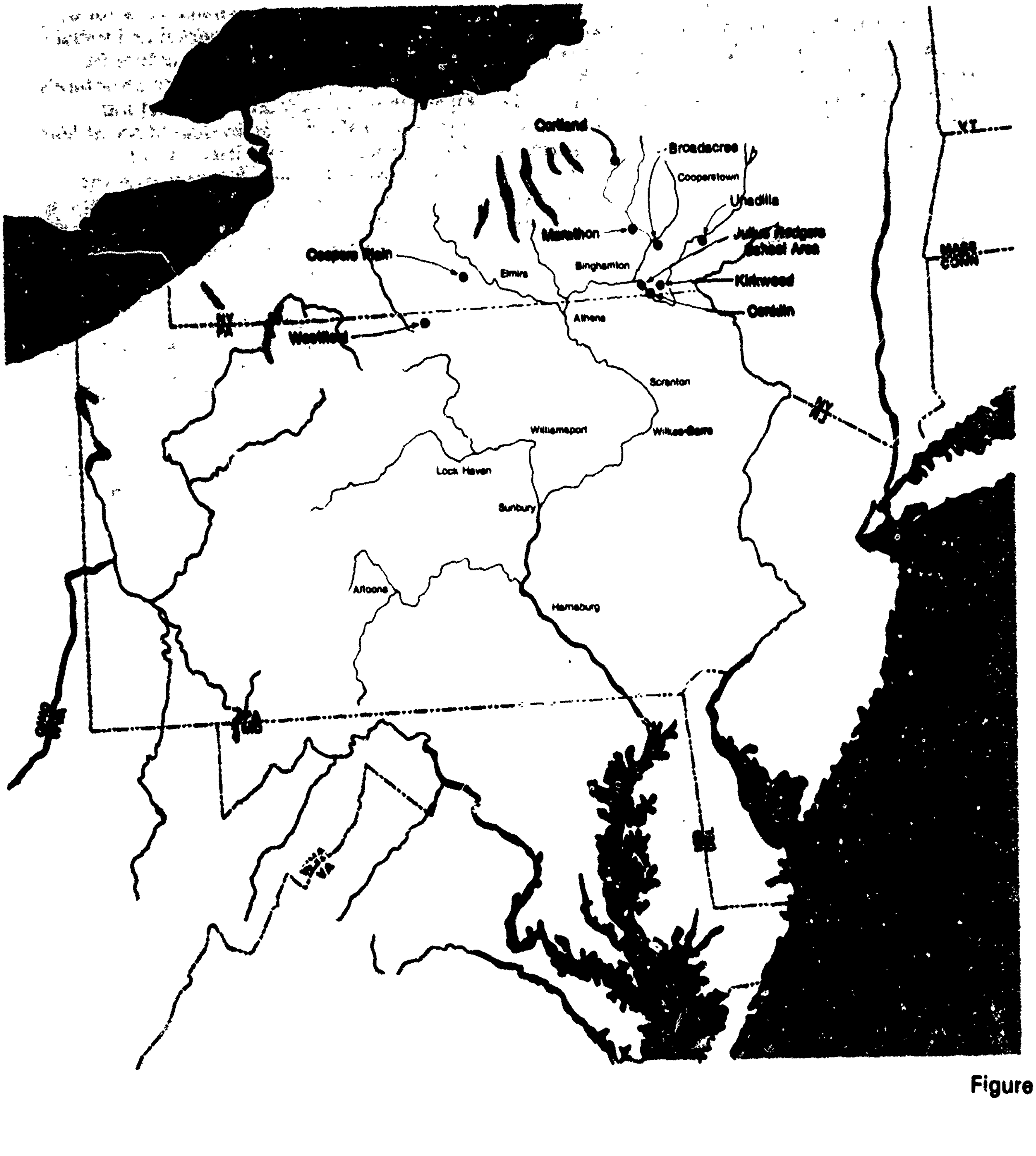

Cortland
Broadacres
Cooperstown
Unadilla
Marathon
School Area
Elmira
Binghamton
Kirkwood
Conklin
Athens
Westfield
Scranton
Wilkes-Barre
Williamsport
Lock Haven
Sunbury
Altoona
Harrisburg
VT
NY
PA

Figure 24

Nonstructural community plans were developed for various levels of protection to determine if a feasible plan existed. This plan formulation considered the type of flooding (i.e., basement, first floor, or both) received by each structure, the number of structures receiving damages, and the frequency of flooding. For each plan(s) of protection considered, nonstructural measures were then recommended for each structure based on inundation depths, individual structural characteristics, location within the flood plain, and consideration of environmental and social concerns. The most applicable nonstructural measure was identified for each structure for various levels of protection. Photographs were helpful in the determination of each structure's susceptibility and flood damage potential in selecting the most appropriate nonstructural solution. For the seven remaining communities, a nonstructural plan was evaluated for at least two levels of flooding. After the most appropriate measure has been identified for all structures they were futher examined with a view toward reasonableness, in relation to the total community plan. Modifications resulting from this review were then incorporated into a final community plan for the level of protection under consideration. An economic analysis was then performed on the various community plans to determine whether or not any of these projects were justified.

Economic Analysis: Economic justification of these nonstructural measures, and all other Federal water resources development projects, is based on the requirements of the 1936 Flood Control Act. The Act requires that the benefits of a project shall exceed the costs of the project, hence the benefit-cost ratio. For a project to be economically justified, the benefit-cost ratio must be greater than or equal to 1.0 to 1.

The economic feasibility of proposed plans can be determined by comparing the average annual economic costs which include interest, amortization, operation and maintenance with an estimate of the average annual benefits, which could be realized over a project life of 50 years. The applicable interest rate used during formulation and evaluation of nonstructural flood control plans is 6-7/8 percent. The value of benefits and costs are based on October 1978 price levels.

Field surveys were conducted during Fall 1978 to collect stage-damage data for the purpose of estimating average annual damages. Benefit evaluation was limited to the estimation of flood damage reduction benefits only. The difference between average annual flood damages before the plan and average annual flood damages after plan implementation would be the average annual benefit to the plan.

Costs for the nonstructural plans are based on estimates developed as part of the comprehensive study for representative communities within the Susquehanna River Basin. A portion of these estimates are based on information supplied by house moving, demolition, and raising contractors. Representative structures were also inspected during field investigations to obtain information affecting costs for the various nonstructural alternatives. Other items such as resettlement and acquisition expenses were based on comparative estimates of previous relocation studies within the Baltimore District. Market value of land and structure were determined based on comparison of recent sales within the community. In addition to the direct cost items as discussed above, a contingency allowance of 20 percent and an engineering, design, supervision and administration allowance of 5 percent were used. Also included as an annual cost are operation and maintenance costs estimated to be 5 percent of the annual costs.

The economic criteria, which were applied in the plan formulation process, required that the annual benefits should exceed the annual costs. Upon conclusion of the economic analysis, if a community plan was found to have a benefit to cost ratio greater than 1.0 to 1.0, it was considered that a more detailed study of that community would be warranted.

Environmental Considerations: Since the purpose of this study is to investigate the feasibility of providing nonstructural flood control measures for a community, the typical environmental criteria usually imposed upon a structural flood control project is not applicable as construction activities would be primarily limited to residential and commercial sites.

The principal impact of nonstructural flood control measures appears to be that associated with the relocation of individual family residences and occupants or the acquisition and demolition of the residence and the subsequent relocation of the occupants to a new area. These impacts take the form of anxiety associated with leaving an established neighborhood and the friends made while living there, in addition to the potential disruption of the neighborhood itself. In an effort to minimize the disruptive influence of relocations, once a measure was defined regarding nonstructural flood control for each structure within the community, the entire community was re-examined to insure that there was a homogeneity of recommended measures, i.e., if the majority of homes along a particular street(s) were slated for differential raising and basement floodproofing and several were slated for relocation, those several structures identified for relocation would be re-examined carefully to determine if they could also be raised and flood proofed to provide continuity within that particular neighborhood.

In those instances where the relocation of dwellings from an area of the flood plain was the principal nonstructural measure to be used, thought should be given to the potential alternative land used of the resulting vacant land. Although not specifically designed for a given community, the concepts of "green-space" adjacent to the river should be considered. Green space, in this instance, implies that either reversion of the flood plain to its natural state or the maintenance of existing natural habitat in areas where vacated space would allow this condition. When combined with local land use controls establilshed specifically for the flood plain, which would prevent the construction of dwellings within these areas, some of the alternative land uses could be stream parks, and natural areas with their attendant recreational features.

It is felt that with the maintenance or reversion of the flood plain back to its natural state, certain positive environmental benefits could be acheived within the community. These benefits might take several forms, i.e., increased local recreational opportunities, the improvement of the riparian (stream/riverside) habitat over the project life, improvement of the adjacent acquatic habitat, and the potential improvement of water quality within the river/stream adjacent the community under investigation. These potential benefits would need to be examined in more detail should more detailed study be warranted.

Nonstructural Community Plan Results: Community plans were developed and evaluated for each of the seven communities. Table 41 summarizes the results of these evaluations and presents the economic analysis. As can be determined from this table, Marathon, Unadilla, and Broadacres, New York were found to lack economic feasibility and are considered further. The remaining four, Conklin, Kirkwood, Julius Rodgers School Area, and Coopers Plain, New York, have at least one community plan, which is economically feasible.

For the three communities (Conklin, Kirkwood, and Julius Rodgers School Area) that are located in Broome County, New York, the greatest flood known to have occured on the Susquehanna River was in March 1936. The earlies known record of flood stage was made in March 1865. Numerous floods prior to that date are mentioned in historic records, the earliest being 1786. Other large floods occured in April 1940, December 1942, and March 1948. Standard project flood determinations indicate that floods could occur on the Susquehanna River in Broome County about 17 feet higher than the March 1936 flood. The main flood season for the Susquehanna River is late winter and early spring. Most of the larger floods have resulted from a combination of moderate snow, sudden thaw with consequent meltoff, and heavy rains.

TABLE 41
COMMUNITY PLAN ECONOMIC ANALYSIS

Interest rate - 6-7/8% Project Life - 50 years (0.07132)
(Oct 78 Price Level)

Community	Plan (yr)	Wet Struct.	1st Cost	A. Cost	O&M (5%)	Total A. Cost	A. Benefit	BCR
Marathon	200	34	498,000	35,600	1,800	37,400	2,600	0.07
Marathon	85	15	165,300	11,800	600	12,400	1,900	0.15
Unadilla	70	42	892,700	63,700	3,200	66,900	5,600	0.08
Unadilla	35	20	375,600	26,800	1,300	28,100	5,600	0.20
Unadilla	210	64	1,354,000	96,600	4,800	101,400	9,200	0.09
Broadacres	240	70	1,643,400	117,200	5,900	123,100	12,500	0.10
Broadacres	100	16	348,000	24,800	1,200	26,000	11,500	0.44
Westfield	NO FLOOD PROBLEM (NO HISTORICAL PROBLEM)							
*Kirkwood	35	55	440,000	31,400	1,600	33,000	34,900	1.06
Conklin	70	148	3,095,700	220,800	11,000	231,800	111,900	0.48
*Conklin	10	36	804,400	57,400	2,900	60,300	70,300	1.17
*Julius Rodgers								
School Area	70	251	4,541,600	323,900	16,200	340,100	343,400	1.01
1 Julius Rogers								
School Area	10	105	1,404,400	100,200	5,000	105,200	199,400	1.90
Coopers Plain	70	325	5,819,000	415,000	20,800	435,800	795,000	1.80
Cortland	NOT RECOMMENDED, NO FLOOD PROBLEM (CHANNEL PROJECT)							

*Completed and Recommended
Blank - Completed and Not Recommended
1 - Recommended, but Use Higher Level of Protection

The duration of floods is comparatively long on the Susquehanna River in this area. For example, during the March 1936 flood, the Susquehanna River had a maximum rate of rise of about 1-foot per hour and remained out of bank for 120 hours. East Sidney Reservoir in the Upper Susquehanna River Basin provides limited protection for Broome County by reducing flood heights along the Susquehanna River throughout the study area. In addition, a channel improvement project consisting of clearing and island removal completed in 1955 also provides limited relief during smaller floods. Even with these flood protection measures, the bankfull stage has been exceeded many times. With this in mind, the need for further protection is clearly evident.

For Coopers Plains, New York the study area is located in a relatively broad flood plain created at the confluence of Meads Creek and the Cohocton River. Historically, many floods have occurred in this area, the most damaging of which typically occur in the months of June and July. Two examples are the July 1935 flood and the June 1972 flood. In addition to fluvial flooding by the Cohocton River, inundation of structures also occurs as a result of fluvial flooding of Meads Creek and from backwater effects resulting from high flows and the Cohocton River and the Tioga River, just below Coopers Plains. The 1935 flood produced average depths of flooding between 2 feet above and 2 feet below most first floor levels. Average depths of flooding during Agnes are estimated between 2 and 4 feet above first floor elevations. During Agnes, flooding occurred due to the fluvial flooding in both Meads Creek and Cohocton River, in addition to the backwater affects.

Brief descriptions of the communities along with their recommended plan are as follows.

Conklin, New York: Conklin is located in Broome County, New York. The community is located on the left bank of the Susquehanna River approximately 2 1/2 miles upstream of the Binghamton City limits.

A field survey performed for the community of Conklin included inventory of 503 structures. Of this total 475 were residential, 4 were trailers, and 24 were nonresidential. The majority of residential structures were class A and class B structures, with basements, poured concrete or block foundations, and in average to good condition. The average market value of these structures ranged from $25,000 to $40,000.

The range of protection considered for this community was the 1936 flood of reference minus 3 feet to the 1936 flood of reference plus 5 feet. The plan identitied as being economically justified is the 1936 minus 3-foot plan which provides protection against the 10-year flood. This plan (Plate 1) provides protection for 36 structures of which 31 are residential and 5 are non-residential. Table 42 shows a breakdown of the number of structures recommended for the associated nonstructural alternatives.

The anticipated major impact associated with this particular plan involves those "personal" social aspects dealing with the anxiety of the individual or family unit when faced with the decision to involuntarily move in their and/or the public interest, although they may not be convinced of the necessity of the move or the validity of the public interest. On the first examination of this community, a number of structures were identified for either acquisition and demolition or relocation. In an effort to reduce this rather drastic method, all structures initially identified for relocation or acquisistion and demoliton were re-examined, and another nonstructural method employed, in an attempt to reduce community and personal family disruption. In the Conklin area the 10-year plan disrupts 14 percent of the investigated community from acquisition and demolition.

Table 42

Nonstructural Community Plans

Community

	Kirkwood N.Y.	Conklin N.Y.	Coopers Plains N.Y.	Julius Rodgers School Area N.Y.	Total For Each Measure
	Level of Protection				
Nonstructural Measures	35-year	10-year	70-year	70-year	
Utility Addition	0	3	4	26	33
Acquire & Demolish	0	5	18	9	32
Relocation	53	0	164	63	280
Raise	1	7	8	14	30
Basement Floodproof	1	15	25	77	118
Raise & Basement Floodproof	0	1	93	22	116
Raise & Utility Addition	0	1	8	17	26
Commercial Floodproof	0	3	5	16	24
Do Nothing	0	1	0	7	8
Residential	2	31	157	167	357
Non-Residential	0	5	12	25	42
Trailers	53	0	156	59	268
Total No. Damaged Struct.	55	36	325	251	667
% of Community	44	7	80	70	

The results of this analysis indicated that the community receives average annual damages of approximately $70,300. The estimated annual cost of reducing the damages is $60,300 and, therefore, a nonstructural project appears economically feasible and justified at this time.

The total cost of a nonstructural project for Conklin has been estimated to be approximately $804,400. The local share is currently estimated to be $161,000.

Kirkwood, N.Y.: Kirkwood is located in Broome County, New York. The community is located on the right bank of the Susquehanna River, approximately 7 miles upstream of the Binghamton City limits.

A field survey performed for this community of Kirkwood included inventory of 126 structures. Of this total 72 were residential, 53 were trailers, and 1 was non-residential. The majority of residential structures were class B structures, without basements, poured concrete or block foundations, and in average condition. The average market value of these structures ranged from $25,000 to $40,000. Most trailers were of small size and average condition. The average market value of these units is estimated at $5,000.

The range of protection considered for the community was the 1936 flood of reference minus 3 feet to the 1936 flood of reference plus 1-foot. The plan (Plate 2) identified as being economically justified is the 1936 minus 1-foot plan which provides protection against the 35-year flood. This plan provides protection for 55 structures of which 2 are residential and 53 are trailers. The Table 42 shows a breakdown of the number of structures recommended for the associated nonstructural measures.

The anticipated major impact associated with this particular plan involves those social aspects dealing with the anxiety of the individual when faced with the decision to involuntarily move in his and the public interest, although he may not be convinced of the necessity of the move. On this particular case, the disruption of a community via relocation is not expected to be significant because of the 55 protected structures, 53 are trailers and all of these are anticipated to be moved. However, additional potential impacts which may occur include but are not limited to the unwillingness of individual trailer owners to move, the location of suitable relocation sites that would maintain the integrity of the community, adequate and prompt financial compensation for the trailer owners and the trailer park owner(s), potential re-zoning procedures to allow for the new and/or re-establishment of trailer parks and the carefully managed use of the vacated flood plain, the proximity and utility of services at the new relocation site, e.g., schools, police, fire department, etc., and how will the anticipated nonstructural project affect the future development of the community. These questions and impacts will need to be thoroughly examined upon entering the next stage of investigation.

The results of this analysis indicated that the community received average annual damages of approximately $34,900. The estimated annual cost of reducing the damages is $31,400 and, therefore, a nonstructural project appears economically feasible and justified at this time. The total cost of a nonstructural project for Kirkwood has been estimated to be approximately $440,000. The local share is currently estimated to be $88,000.

Julius Rogers School Area, N.Y.: This community is adjacent to Conklin, in Broome County. A field survey performed for this community included inventory of 360 structures. Of this total 244 were residential, 59 were trailers, and 57 were non-residential. The majority of residential structures were class B structures, with basement, poured concrete or block foundations, and in good condition. The average market value of these structures ranged from $25,000 to $40,000. Most trailers were of small size and average condition. The average market value of these units is estimated at $10,000.

The range of protection considered for the community was the 1936 flood of reference minus 3 feet to the 1936 flood of reference plus 5 feet. The plans identified as being economically justified are the 1936 and 1936 minus 3-foot plans which provide protection against the 70- and 10-year floods, respectively.

The 70-year plan (Plate 3) provides protection for 251 structures of which 167 are residential, 59 are trailers, and 25 are non-residential. Table 42 shows a breakdown of the number of structures recommended for the associated nonstructural measures. The 10-year plan provides protection for 105 structures of which 40 are residential, 55 are trailers, and 10 are non-residential. It was judged to be not as effective as the 70-year plan.

The anticipated major impact associated with this particular plan involves those "personal" social aspects dealing with the anxiety of the individual or family unit when faced with the decision to involuntarily move in their and/or the public interest, although they may not be convinced of the necessity of the move or the validity of the public interest. On the first examination of this community, a number of structures were identified for either acquisition and demolition or relocation. In an effort to reduce this rather drastic method, all structures initially identified for relocation or acquistion and demolition were re-examined and another nonstructural method employed, in an attempt to reduce community and personal family disruption. In the Julius Rodgers School area, the 70-year plan disrupts 29 percent of the investigated community via relocation and acquisition and demolition while the 10-year plan disrupts 60 percent. In both cases, the majority (over 80 percent) of the effected structures are trailer homes.

The results of this analysis indicated that for the 70-year plan this community receives average annual damages of approximately $343,400. The estimated annual cost of reducing the damages is $340,100, therefore, a nonstructural project appears economically feasible and justified at this time. The total cost of a nonstructural project for the Julius Rodgers School Area has been estimated to be approximately $4,541,600. The local share is currently estimated to be $908,300.

Coopers Plain, N.Y.: Coopers Plains is located in the Town of Erwin in Steuben County, New York. The community is located on the left bank of the Cohocton River approximately 2 miles upstream of the confluence with the Tioga River.

A field survey performed for the community of Coopers Plains included inventory of 411 structures. Of this total 232 were residential, 161 were trailers, and 18 were non-residential. The majority of residential structures were class B structures, with basements, poured concrete or block foundations, and in very good condition. The average market value of these structures ranged from $25,000 to $40,000. Most trailers were of average size and in very good condition. The average market value of these units is estimated at $15,000.

The range of protection considered for this community was the 1972 flood of reference minus 2 feet to the 1972 flood of reference plus 1 foot. The plan (Plate 4) identified as being economically justified is the 1972 plan which provides protection against the 70-year flood. This plan provides protection for 325 structures of which 157 are residential, 156 are trailers, and 12 are non-residential. Table 42 shows a breakdown of the number of structures recommended for the associated nonstructural measures.

The anticipated major impact associated with this particular plan involves those "personal" social aspects dealing with the anxiety of the individual or family unit when faced with the decision to involuntarily move in their and/or the public interest, although they may not be convinced of the necessity of the move or the validity of the public interest. On the first

examination of this community, a number of structures were identified for either acquisition and demolition or relocation. In an effort to reduce this rather drastic method, all structures initially identified for relocation or acquisition and demolition and were re-examined and another nonstructural method employed, an attempt to reduce community and personal family disruption. In the Coopers Plains community, the 70-year plan disrupts 56 percent of the investigated community via relocation and acquisition and demolition. In this case, the majority (over 90 percent) of the effected structures are trailer homes.

The results of this analysis indicated that the community receives average annual damages of approximately \$795,000. The estimated annual cost of reducing the damages is \$435,800 and, therefore, a nonstructural project appears economically feasible and justified at this time. The total cost of a nonstructural project for Coopers Plains has been estimated to be approximately \$5,819,000. The local share is currently estimated to be \$1,164,000.

Additional potential problems and impacts which may also occur with nonstructural measures include, but are not limited to the following:

a. The unwillingness of the individual residents to move from their present location.

b. The identification of suitable relocation sites that would maintain the integrity of the community.

c. Adequate and prompt financial compensation for home owners, business owners, etc., to insure the credibility of the Corps and its policies.

d. The establishment of re-zoning procedures to allow for the siting of new residences and businesses and the responsibly managed use of the vacated flood plain.

e. The provision by the local government of adequate services, i.e., schools, police, fire department, etc., at the new relocation site(s).

f. How will the anticipated nonstructural plan affect the future development of the community?

These questions and impacts will need to be thoroughly examined upon entering the next stage of investigation.

Nonstructural Conclusions: By the very nature of nonstructural measures, community and individual changes are bound to occur. The preliminary plans developed for these four communities involve the relocation of structures and their inhabitants and modifications to individual structures. Because of the economic and social impacts of such plans on a community, community officials must decide whether to pursue these plans further. This detailed study indicates that it may be possible for a community to receive Federal assistance to lessen the flood problem, including a maximum Federal share of 80 percent of the project cost. Further study of a nonstructural project and even eventual implementation would only be undertaken if it was desired and supported by community officials.

Flood Forecast and Warning

Following the devastation resulting from Tropical Storm Agnes in June, 1972, the Corps of Engineers was directed by Congress to conduct a Flood Control Review Study of the Susquehanna basin. The purpose of the review study was to determine if any improvements or additions to the existing flood control system would be feasible as federal projects. Various flood damage reduction alternatives for the basin were reviewed including flood forecasting and warning.

Agency Participants: The Susquehanna River Basin Commission (SRBC) had completed a preliminary investigation of the basin flood warning system. Because of that activity and the Commission's intergovernmental coordination responsibility, the Baltimore District Engineer, Corps of Engineers, requested the SRBC to chair an Interagency Task Force to undertake an analysis of the basinwide flood forecasting and warning system. Inter-agency Task Force members are:

Susquehanna River Basin Commission (Land agency)
National Weather Service
U.S. Geological Survey
Corps of Engineers
New York State Dept. of Environmental Conservation
New York State Division of Military and Naval Affairs
Pennsylvania Dept. of Environmental Resources
Pennsylvania State Council of Civil Defense
Maryland Dept. of Natural Resources

System Purpose: The river flood forecasting and warning system in the Susquehanna River basin has been developed for and is operated to provide advance warning of flooding conditions which threaten human life and can cause property damage. There are two types of warnings: (1) flash flood watch or warning, and (2) basinwide and river flood forecast warnings. Flash flood watches or warnings provide an advance alert of possible flooding situations in general areas. Basinwide river flood forecasts and warnings, on the other hand, predict water heights for specific points on the Susquehanna River and its major tributaries.

System Overview: The basinwide river flood forecast and warning system is operated by the National Weather Service (NWS), a component of NOAA (National Oceanic and Atmospheric Administration), Department of Commerce. Rainfall reports and river gage reading are assembled by the National Water Service River District Offices (RDO's) at Buffalo, Albany and Harrisburg, and the Weather Service Office (WSO) at Williamsport, and sent to the Middle Atlantic River Forecast Center (MARFC) at Harrisburg. The Center prepares river flood forecasts and transmits them to the RDO's where the river forecast is issued to state and county agencies and the news media for public dissemination. It then becomes the responsibility of the community and each individual to respond to the situation by taking whatever measures are considered necessary to protect life and reduce property damage.

Flash flood watches and warnings operate differently. A local office of the National Weather Service either based upon weather forecasts or upon receiving reports of changing weather conditions or heavy rainfall will issue, if warranted, a flash flood watch or warning directly to counties or areas of responsibility for which a flooding potential exists. This activity is not a function of the River Forecast Center.

System Components: The components of the flood forecasting and warning system, some of which are operated by different levels of government, are:

1. Data collection;
2. Data assembly;
3. Forecast preparation;
4. Forecast dissemination;
5. Reservoir regulation; and
6. Local action - response.

The data collection component consists of weather reports and predictions, rainfall reports, river level reports and reservoir data reports. Figure 25 shows data assembly points in the basin.

Data assembly includes several different communications systems between data gathering points which forward collected data to the MARFC at Harrisburg. Telephone, teletype, computer terminals, and when needed, and emergency radio system operated by the Corps of Engineers are used. Figure 26 illustrates the data assembly and transfer system.

All of the pertinent data obtainable is assembed at the MARFC for flood forecast preparation. since many factors must be considered in preparing a forecast, a computer program is used to make the calculations. Flash flood watches and warnings which provide a quick alert of possible flooding are issued by any local National Weather Service when necessary.

The forecast dissemination system consists of telephone and teletype system which transmit forecasts from the Harrisburg Center to RDO's at Albany and Buffalo. MARFC at Harrisburg also serves as a RDO. The RDO's then distribute the forecast to state and county agencies, mass media (radio, television and newspapers) who then issue public message. Figure 27 diagrams the forecast dissemination system.

The Corps of Engineers operates a reservoir regulation system to reduce or modify flood flows. Reservoir regulation is managed from the District Reservoir Control Center (DRCC) at Baltimore, Maryland and is coordinated closely with the MARFC who include reservoir discharges in flood forecast procedures.

Local action and response to flood warnings taken by county and local government agencies often determine the reactions of individuals to a flood warning.

Each of the system's six separate components must be combined into a unified and coordinated working operation to make the flood warning system operate effectively. System operation relies upon all levels of government to perform their functions in a timely manner. Otherwise, forecasts will not be timely or reliable.

System Needs: The evaluation of the system identified problem areas which must be solved before further improvement in the flood warning system in the Susquehanna River basin can take place. These problems or areas of need are:

(1) speeding up the river forecasting process;
(2) increasing the reliability of the river forecasting system;
(3) improving flash flood warning;
(4) improving local response; and
(5) providing ongoing review of the forecasting system.

The following sections of this chapter review findings in each of the above listed areas and make recommendations for future improvement of the system.

Accelerating the River Forecasting Process: Reducing the time required to produce a forecast will allow greater time for evacuation of people, goods and belongings thereby reducing flood damage losses. The evaluation determined that speeding up the time needed to make river forecasts is an area requiring priority attention.

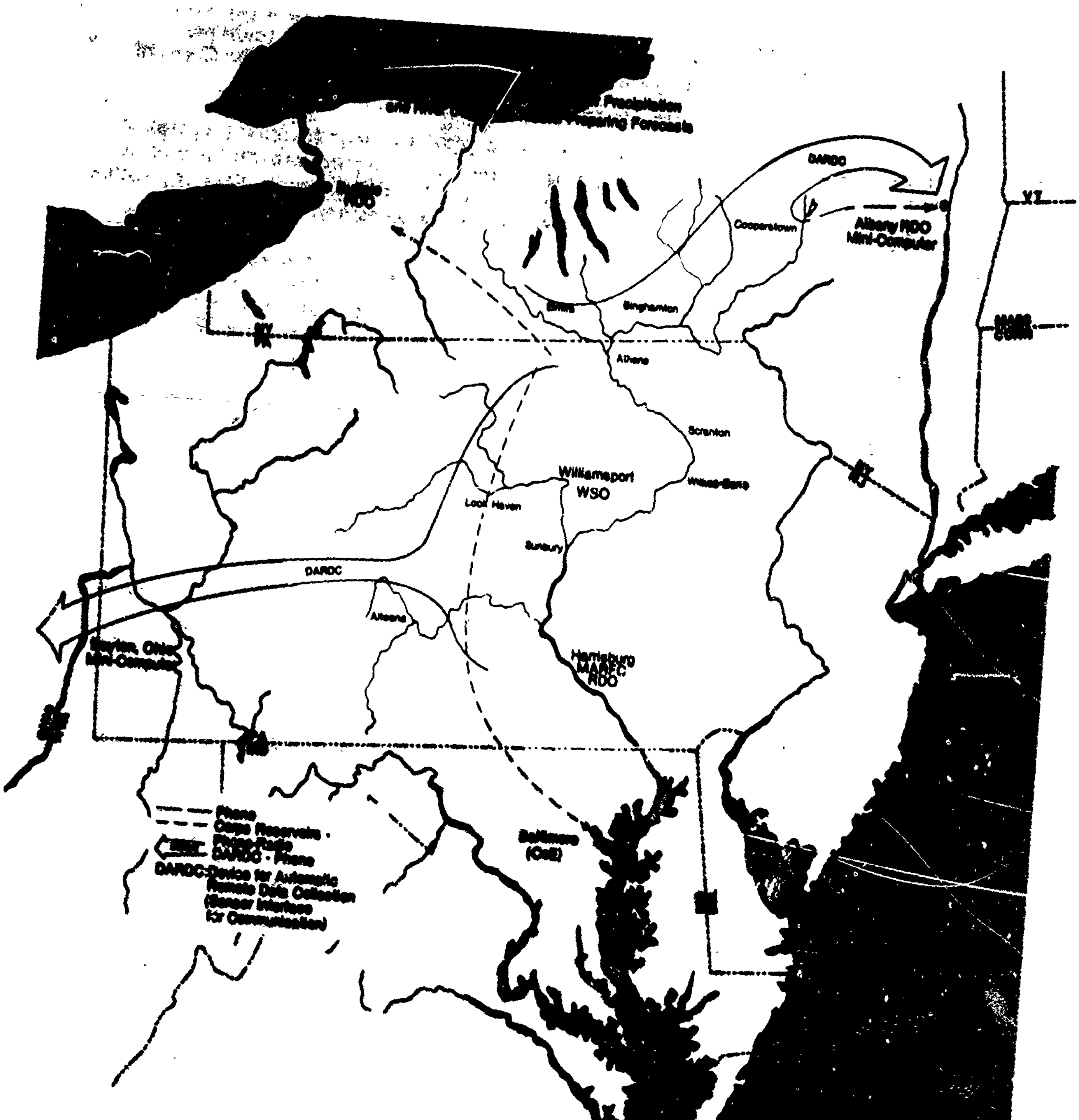
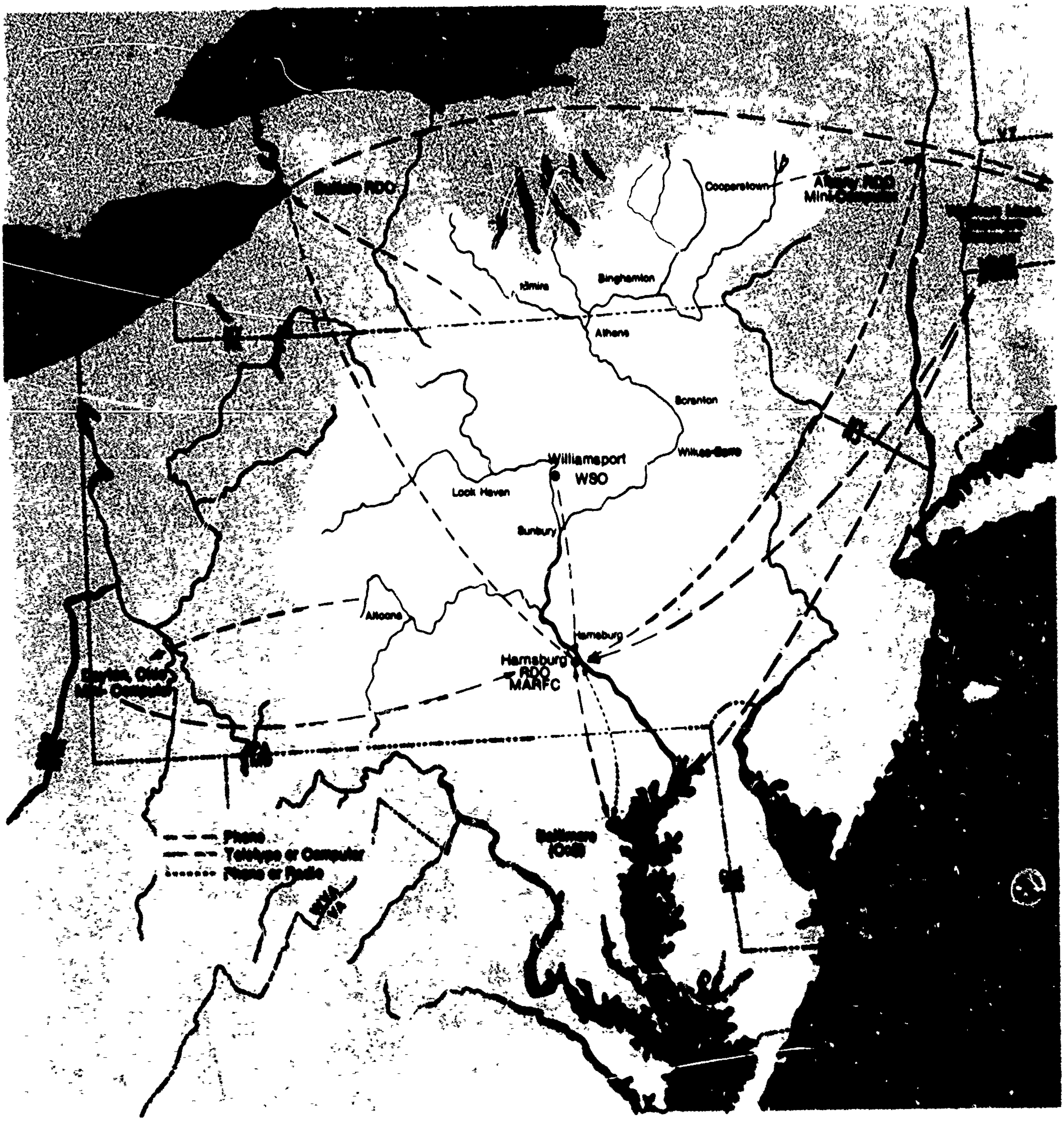

DARDC
Cooperstown
Albany RDO
Mini-Computer
Elmira
Binghamton
Athens
Scranton
Williamsport
WSO
Wilkes-Barre
Lock Haven
Sunbury
DARDC
Altoona
Harrisburg
MARFC
RDO
Baltimore
(CoE)
Dayton, Ohio
Mini-Computer
Phone
Corps Reservoirs -
Phone-Radio
DARDC - Phone
DARDC-Device for Automatic
Remote Data Collection
(Sensor Interface
for Communication)

Figure 25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WSO
Lock Haven
Sunbury
Altoona
Harrisburg
Harrisburg
RDO
MARFC

Figure 26

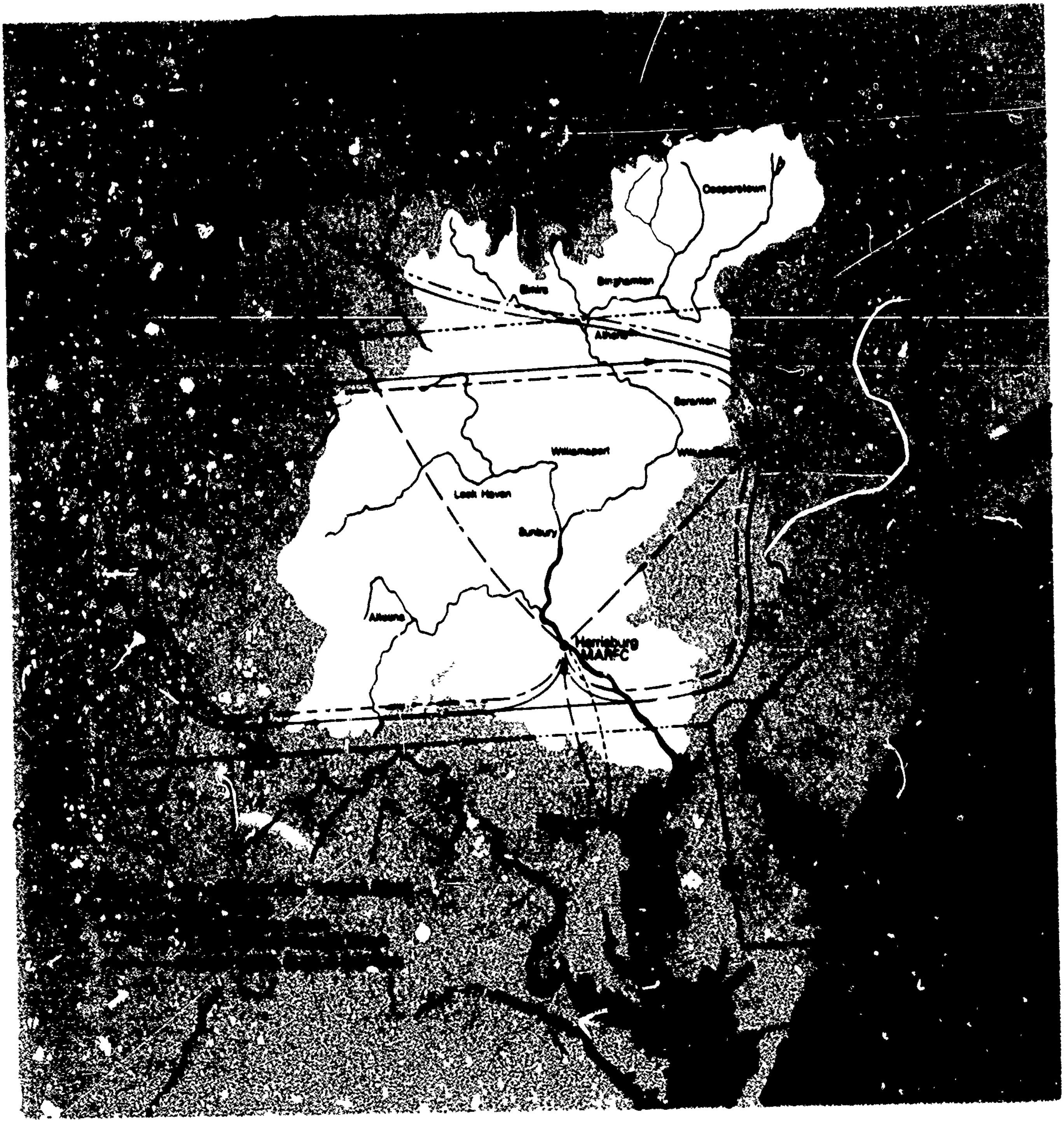
Cooperstown
Binghamton
Scranton
Williamsport
Lock Haven
Sunbury
Altoona
Harrisburg
MARFC

Figure 27

The existing river forecasting system is too slow to provide timely flood forecasts for upstream areas on main rivers. It sometimes takes over 6 hours to assemble data, transfer it to the forecast center, prepare a forecast and disseminate it. The reasons for this time lag are: (1) data are not collected rapidly enough; (2) delays in data transfer; and (3) during extensive/prolonged storms there is a lack of hydrology staff personnel at forecast centers. The MARFC is staffed to provide one full shift of coverage Monday to Friday. Additional coverage is met through use of overtime.

Automatic gages provide the most rapid method of collecting telemetering information. The existing pattern of automatic telemetering precipitation gages is not dense enough to detect flood producing rainfall in enough locations to produce a rapid river flood forecast. Observer reports are currently used to fill in these gaps and data collection is delayed because it takes longer to receive and transfer observer reports.

Snowmelt runoff is difficult to evaluate because existing snow survey stations are located in the valleys and do not accurately indicate average snow depth and water content. A more accurate and representative system of determining snowmelt runoff is needed.

River stage information provided by automatic telemetering gages is also used in making river forecasts. The existing river gaging system is adequate for most needs; however, it is essential that there be early detection of high river flows in some upstream locations. There are several areas (mainly in New York) where there are no public reference staff gages to obtain emergency river gage readings when automatic equipment is not working.

Data collection depends on facilities at several widely dispersed locations, some of which are located far out of the basin (Dayton, Ohio and Albany and Buffalo, N.Y.). These dispersed offices have other river basins to be concerned about and sometimes cannot devote sufficient time to the Susquehanna basin. In addition, the long distances involve complicate emergency communications.

Collection and transfer of data from data collection points to MARFC is often slow. ADAS, the Automatic Data Acquisition System, is too slow and can be restricted at times by other uses of the system to collect upper air computer runs. At some data collection points data transfer is done manually between different communication systems, a slow and cumbersome procedure.

During extensive storms, hydrologists (flood forecast personnel) at NWS offices become overburdened with work resulting in delays and slowing down of forecast preparation. This is especially a problem at the National Weather Service Office at Harrisubrg which is a co-located office (Weather Service Office, River Forecast Center and River District Office). That is, the same staff and equipment are responsible for several jobs; river forecast preparation for a multi-state area, flood forecast dissemination for the Pennsylvania portion of the basin, and weather forecast dissemination for a multi-county area in Central Pennsylvania. During major or extensive storms, data collection and forecast dissemination can delay forecast preparation.

Increased Reliability of the River Forecast System: During major storms, breakdowns in the river forecast system have occurred. Many improvements have been made but there remain parts of the system which are subject to break-down or failure.

The most serious deficiency is the failure of the telephone communications system and its disruptive effect on the river forecast system. Data assembly, data transfer and forecast dissemination are dependent on the telephone system and therefore subject to breakdowns at critical times.

To better evaluate this aspect of the flood warning system, a separate review of the flood forecast and warning communication system was undertaken as part of this study. This review made general comparisons of the existing system with other communications systems. It identified that alternative communications systems such as meteor burst, microwave radio and satellite communications systems have justification for additional investigation. Subsequent review of other studies revealed that meteor burst, commercial satellite and government-owned satellite are becoming cost competitive with existing data collection systems.

An alternate satellite data collection system is now being tested. Hourly river gage readings are being obtained by the Harrisburg River Forecast Center with real time delays of up to 3 hours. There are, however, potential problems with the system. The satellite receiving antennae at Wallops Island, Va. must be protected when winds are expected to exceed 60 miles per hour and communications of data to Harrisburg over telephone lines may be subject to weather interference.

This test has shown that data collection over a satellite system is feasible, however, detailed cost evaluations have not been completed at this time. There are also test programs of the satellite and meteor burst systems in other parts of the country which are currently underway.

The Corps of Engineers radio system offers a back-up system for assembling some data. It is not possible, however, to add a great number of locations to the existing system. The greatest need is to provide back-up emergency communications between National Weather Service offices serving the basin and Corps of Engineers dam operators and reservoir control offices.

Susquehanna River forecasts are produced using a NWS computer facility at Suitland, Md. with interconnections at a computer terminal at MARFC. There is no back-up computer and delays have been caused by computer shut-down at Suitland.

National Weather Service RFC's and RDO's responsible for the river forecasting system become overwhelmed with work during major storms. If the storm lasts for several days, staff cannot properly perform their jobs, and the large numbers of requests from the public and other agencies place additional pressures on available time, often delaying forecasts and disrupting forecast updates.

Forecast dissemination is also subject to disruption with failure of the telephone system. There is no alternate emergency communications system for forecast dissemination. Pennsylvania has installed a statewide teletype system for forecast dissemination; however, this is land line dependent. In New York, the NAWAS telephone based phone system is also a land line system. There is no radio system organized for forecast dissemination basinwide. There are, however, radio systems of state agencies which provide partial coverage for forecast dissemination.

Major improvements in the forecast dissemination system are needed for more rapid and reliable transfers of forecasts between forecasters and users. Alternate emergency communication system, which do not rely on the telephone, are needed from forecast points to all flood prone communities.

Evaluation of the feasibility of the use of satellite or other communications systems needs to be done to determine its applicability for forecast dissemination. This study has not identified sufficient information to determine the practicality of using alternate systems for anything other than data collection.

The National Weather Service is planning or has installed NOAA all-weather radio stations which are located to reach a high percentage of the public in the basin. However, if the

transfer of forecast information to these transmitter locations is over land line telephone communications, it will be subject to interruption.

Improvements in disseminating the forecast and integration of forecast efforts between those who forecast and those who take action has many potential benefits in flood damage reduction. Including forecast dissemination as part of a package of warning-action-response, rather than as a separate unrelated component of the forecast system, will improve system performance and reliability. development of alternative forecast methods, coordination of the dissemination system, and more careful linking of the forecast system with action agency users at the county and community level will strengthen the overall system.

States play a crucial role in the coordination of the flood warning system and the integration of the Federal program to local community needs. Only through carefully planned and tested efforts will a flood forecast produced by the National Weather Service be transferred to the flood prone community that needs it. The states play a crucial role in insuring that a speedy and reliable forecast transfer system is operating.

Improved Flash Flood Warning: Flash flooding is a common occurrence in the Susquehanna River basin. Some areas experience flash flood damage almost each year.

The existing flash flood "watch" provided by the National Weather Service provides adequate advance notification of possible flash flooding. However, the NWS "flash flood warning", notification of flash floods occurring, is often too late to be of value in protecting lives and reducing property damage. It, therefore, is the conclusion of this system for flash flooding is a warning system operated at the local level where rainfall observations key local flood damage reduction actions.

The techniques and operational procedures are available for locally operated flash flood warning systems. Susquehanna River Basin Commission Publication No. 42, "Planning Guide Self-Help Forecast and Warning System Swatara Creek Watershed, Pennsylvania" and No. 45, "Neighborhood Flash Flood Warning Program Manual" detail the organizational methods and procedures to use in local flood warning programs. In addition, the National Weather Service provides technical manuals for local flood warning use. What is needed to put these programs into operation is local leadership and operational coordination. County emergency preparedness staff are in the best position to provide the leadership and authority to get these programs operational.

Each county should make provision for a person or persons with professional training and experience in the technical and planning fields.

Improving Local Response: Response to a flood warning is determined by the actions of individuals and groups or organizations at the local community level. The most effective actions that result in saved lives and reduced damages are those that are the result of pre-planned organized efforts by a co-ordinated community effort. This section identifies problems and weaknesses in local performance and makes recommendations to federal and state, county and community levels of government for the most effective support and improvement of these actions.

The evaluation has identified that flood warning and damage reduction actions at the local community level have received too little support in the past. Assistance provided to the community is often a minor part of state or county government programs.

Improvements in the development of alternative forecast methods, coordination of the forecast system and more careful lin' ' of forecast dissemination with action agency users at the county and community lev wi do much to improve the performance of the system. The system should be designed as a package of warning-action-response.

The complex warning system described in previous sections of this report relates for the main part to large main stream communities. It often does not consider adequately the particular concerns and needs of communities on smaller streams.

There are pre-flood disaster plans for a few communities; however, there are many others which have done no planning or plans are in need of updating. In almost every flood prone community many benefits could be attained through detailed evacuation planning that consider various flood levels. The disaster planning which federal and state agencies have carried out has provided generalized planning assistance related to nuclear attack and statewide disaster operational plans but with only limited assistance for community pre-flood disaster plans. Federal and state agency support of pre-disaster planning at the community level would result in many benefits from reduced flood damages and saved lives.

A consistent consolidated federal disaster preparedness policy and program must be developed that support dual purpose natural and man-made disaster preparedness. Federal programs should be coordinated and oriented toward improving total disaster preparedness of county and local government. Federal financial support is needed to provide the planning, organizational structure, emergency communications capability and training to meet this objective.

The amount of leadership, funding and coordination provided at the state level determines the effectiveness of local programs. States must assume a responsibility for integrating Federal and state support with county and community needs. States should advocate increased responsibility and improved county and community capability in disaster preparedness programs. A continuing program of training and testing operational capability for disaster warnings and actions will be needed.

States need to evaluate the performance capability of existing warning dissemination systems during major storms to determine potential of disruption and failure of the system. This review should evaluate the capability of emergency radio systems to disseminate forecasts and warnings to all flood prone communities and determine the most rapid and efficient method of coordinating and linking emergency radio systems. County and community emergency communications needs should be determined and appropriate federal and state funding programs implemented to assist in the development of improved systems.

County government is the level of government with the greatest potential of assemblying and managing the resources necessary to coordinate and direct community flood warning actions. therefore, the qualities and capabilities of county emergency preparedness staff, working in support of elected officials, is the key to planned local flood warning actions. Full time trained leadership at the county level is needed to carrry out the organization, coordination and decision-making to most effectively use county and community staff, equipment and volunteer resources. To be effective, county staff need to have a clear designation of authority and responsibility, with established decision-making delegated by elected officials. Staff needs sufficient training to perform this function.

Action by local government officials, employees and volunteers is the focal point of flood damage reduction. Training and coordination of community resources and actions are needed for an effective program. During a flood, pre-planned and tested action is needed. Many communities do not have disaster preparedness plans.

Need for Ongoing System Review: The organization and coordination of the flood forecasting system determines, to a large degree, how effective the system operates.

The existing flood forecasting system has evolved over a number of years with equipment and organizational methods an outgrowth of this development. The National Weather Service has the responsibility of coordination of the federal system, with support by USGS and the Corps of Engineers. Coordination with state and local government, however, has not been given the attention that it needs. Federal agencies have held independent separate reviews with the states; however, no overall review has been carried out with all affected state and federal agencies. A scheduled periodic review of system components and operational procedures is needed for most effective coordination and for planning system improvements.

The Task Force report, "Flood Forecast and Warning System Evaluation-Susquehann River Basin, N.Y., Pa. and Md." was published in Jan. 1979.

Public Views

PUBLIC INVOLVEMENT PROGRAM

Public input into the planning process is a necessary ingredient of any study. Without a thorough knowledge and understanding of the public posture, technical solutions cannot be properly evaluated. To provide a means by which the public could provide input to the planners, a public involvement program was established. The key to the successful implementation of the program was the establishment of an effective communication system between the planners and the public. Responsibilities for the effectiveness of the program lie with both the public and the planners. Citizens must take an active role in the planning process and make their needs and preferences known to the planners, who, in turn must keep the citizens informed as to the progress of the study and incorporate the ideas of the citizens into the study results to the maximum extent possible. Once this communication is established, the planners and the public can work together to achieve common goals, resolve conflicts, and reach agreement on possible solutions that are acceptable not only from a technical standpoint but from a public one as well.

Objectives

The broad general objective of the public involvement program was to actively involve the study area residents and officials in the planning and decision-making process so the planners can determine the publics feelings and integrate their ideas into any recommendations that result from the study.

The specific objectives of the program were as follows:

a. To build confidence and trust in the planning process, procedures and individuals doing the study by promoting public understanding of the manner and means by which flood control studies are conducted and solutions proposed.

b. To open and maintain channels of communications whereby the planners can provide to the public information on the planning process and obtain from the public comments, views and perceptions on the study.

c. To provide clearly defined channels through which the public can submit to the planners their goals, priorities and preferences so the planners can give full consideration to the public needs during the planning process.

d. To coordinate the study with the water and related land resources planning elements of all Federal, State and local agencies.

e. To enhance the public's understanding of Federal, State, Regional and local responsibilities, authorities and procedures in conducting the study and implementing any recommendations.

Program Elements

The public is defined as any non-Corps of Engineers entity to include State and other Federal agencies as well as interested local governments, organizations, and individuals with an interest

in the study. The methods discussed below were utilized to establish the channels of communication necessary to an effective public involvement program.

Agency Coordination

Many Federal and State agencies have the authority to plan, recommend and carry out, or provide assistance to local governments in carrying out programs for the reduction of flood damage problems. Coordination among these agencies is necessary to avoid duplication of effort and to arrive at solutions that are acceptable to each agency. Review study planners made a concerted effort to keep the interested agencies informed of all study developments. These efforts included numerous briefings, slide presentations, informal meetings, and an extensive correspondence program with representative of these agencies. However, the major coordination effort was accomplished through the formation of a Plan Formulation Workshop. This workshop, established in October 1975, included representatives of the fourteen agencies shown in Table 43. The workshops were established to:

a. Provide input to study from Federal and State agencies.

b. Make Corps planners aware of programs or needs of other agencies which could be incorporated into or satisfied by components of the resulting flood plan; and

c. Provide the members the opportunity to evaluate and make recommendations on the flood control alternative in the basin.

At the first meeting, study planners provided workshop members with background information on the Review Study and a schedule of the work remaining to be completed. Subsequent meetings included such topics as existing data base, methodology for evaluating non-structural measures, development of a flood control plan which would have a mix of structural and non-structural measures, incorporation of multi-purpose objectives into a flood control plan, and the evaluation and assessment of the impacts of various alternatives. In addition to the workshop meetings, periodic reports of study progress and findings were forwarded to workshop members for review and comment.

TABLE 43

MEMBER AGENCIES

PLAN FORMULATION WORKSHOP

United States Geological Survey (USGS)
Federal Power Commission (FPC)
United States Fish and Wildlife Service (USFWS)
Soil Conservation Service (SCS)
Department of Health, Education and Welfare (HEW)
Bureau of Outdoor Recreation (BOR)
Susquehanna River Basin Commission (SRBC)
Environmental Protection Agency (EPA)
Department of Housing and Urban Development (DHUD)
Bureau of Sport Fisheries and Wildlife (BSFW)
National Weather Service (NWS)
State of Maryland (DNR and Planning)
Commonwealth of Pennsylvania (DER, Planning and DCA)
State of New York (DEC and Planning)

In addition to the Plan Formulation Workshops, an interagency task force was formed to evaluate the existing flood forecast and warning system and to develop an optimum plan for improving the system. This task force was chaired by the Susquehanna River Basin Commission and included representatives of State and Federal agencies. The objective of the task force were to identify and describe the existing system, formulate an optimum system of guages, develop an effective communication network, and develop a plan for dissemination of forecasts and warnings. The results of the task force study were published in a report entitled "Flood Forecast and Warning System Evaluation Susquehanna River Basin New York, Pennsylvania, and Maryland" in January 1979.

Meetings with Local Officials

Corps planners met with officials of many cities, boroughs, and townships during the course of this study. These meetings proved to be an excellent technique for obtaining and providing information relative to specific areas of the study. The meetings, many of which were attended by citizens as well as officials, were generally geared to what the planners were doing for the particular area in which the meeting was held and gave the citizens, either through active participation or through their elected officials, the opportunity to stress their needs and preferences. The general sentiment expressed after these meetings was that the officials and citizens had a better understanding of the planning process and appreciated this means of submitting their ideas for consideration.

Information Report

In the early stages of the study, a public information pamphlet entitled "A Community Decision - Managing the Binghamton Area Flood Plain" was prepared and distributed to government agencies, community organizations, and interested individuals throughout the Binghamton, New York, area. The information in this pamphlet was applicable to all areas of the study and informed the public of:

a. The existing flood protection works in the area;

b. The adequacy of these works in an Agnes-type situation;

c. The alternative measures of flood plain management including both structural and non-structural measures; and

d. The purpose and goals of the Flood Control Review Study.

This pamphlet was well received by many professional planners but the response of the Binghamton area public was not as good as expected. Because of the poor return on this public involvement investment, this technique was not applied to any other area of the basin.

News Media

In an effort to reach as many study area residents as possible, Corps planners requested the assistance of the news media in disseminating study information. The willingness of newspaper, radio and television management personnel to provide support in the form of media coverage greatly enhanced the program to involve the public. The coverage they provided enabled the planners to reach a much larger segment of the interested public than could have been reached by other methods.

Newspapers: Newspapers throughout the study area published articles on all activities of the public involvement program. These included articles to announce public meetings and workshops, interviews with study planners, editorials, and synopses of informal and formal meetings with local officials, groups, and organizations. Feature articles on study progress and alternatives as they were formulated were also printed. Figures 28 and 29 are examples of the articles published during the study.

Radio and Television: Study planners appeared as guests on several radio and televison "talk" shows. During these shows, planners responded to questions from the station staff and to telephoned questions from the public. The response of the public to this public involvement effort indicated that it was a very successful method of informing the public of the purpose, scope, and progress of the study.

Citizen Committees

Realization that the standard methods of public involvement could not reach all concerned basin residents prompted the Corps to suggest that local and regional planning agencies form citizen committees to work with the planners during the planning process. Two committees, the Citizens Involvement Committee and the Citizens Advisory Council, were established. These committees were composed of members representing a cross-section of basin interests to include environmental/conservation groups, industrial concerns, political action groups, public service agencies, and community organizations. Committee representatives served as a conduit of information, opinions, desires, and reactions between the public and the Corps' planners. Numerous meetings and an extensive correspondence program between the planners and the committed members provided input to insure a more comprehensive integration of citizen views into the planning process. One example of committee input is shown is Figure 30.

Public Workshops and Meetings

Public workshops and meetings are an integral part of any public involvement program because they provide for direct contact between planners the planners and large numbers of the public, collectively. Workshops are informal group discussions between planners and the public and are utilized as a forum to present study progress and findings relative to specific aspects of the study and for recieving public input on all or any of these aspects. Public meetings are more formal discussions whereby planners can present to the public information on all aspects of the study to include the study objectives, process, findings and recommendations and the public can make formal statements regarding their acceptance or rejection of the recommended alternatives and present their views and preferences relative to the study. This direct communication problem provides the Corps with a better understanding of the public posture and gives the public with a better understanding of the planning process and the ways in which alternatives are selected and recommended.

For the convenience of the widely dispersed study area publics, public workshops and meetings were conducted at different locations in the basin. The meetings were held at the locations planners felt would be most affected by the study results and most accessible to the interested public. Table 44 shows the date and location of each major meeting and describes the portion of the basin to which it pertained. Prior to each meeting, public meeting announcements were mailed to the public and press releases for articles announcing the meeting were furnished to local newspapers. Samples of the announcements and newspaper articles are shown on Figures 31, and 32, respectively.

Afternoon and evening workshops preceded each of the five major public workshops and meetings conducted during the Review Study. Like the public meetings, these workshops

Engineer says flood problems won't recede

By MIKE BROWN

A U. S. Army Corps of Engineers spokesman told Binghamton officials last night construction of major reservoirs in Broome and surrounding counties may be necessary to prevent the possibility of major flooding in the future.

Col. Robert McGarry, a district engineer for the Susquehanna River basin, said the Binghamton area does not have sufficient flood protection in the event of a major storm.

It is time, he said, for city leaders to search for solutions.

"One of our findings has been that people here don't know they have a problem," said McGarry at an informational meeting in City Hall. "And it's a problem that just won't go away."

McGarry said that if Tropical Storm Agnes had moved east in June, 1972 and struck Broome County as it did Elmira, the result would have been about $850 million in damage.

"There is a strong feeling against major reservoirs in this state, yet if we're going to get additional flood control for Binghamton, we're probably going to need major reservoirs," he said.

McGarry said existing retaining walls along waterways could not cope with a storm like Agnes, a possibility he said area residents have been ignoring.

"I'm a little concerned about the apathy here," said McGarry. "Just because Agnes didn't come here people think that will never happen here."

Although he said major reservoir construction was not the only way to protect against major flooding, it might be the best solution, he said.

But he said the Corps of Engineers will not make a recommendation to government leaders until it completes a three-year, $1 million study of the Susquehanna basin. The results are not expected until 1977.

McGarry said potential sites for major reservoirs would include positions on the Susquehanna River southeast of Binghamton, near Great Bend, Pa.; Genegantslet Creek, west of Greene; Canasawacta Creek near South Plymouth; Otego Creek near West Oneonta; Charlotte Creek near Davenport Center; Butternut Creek near Copes Corner; and on Unadilla River near East Guilford.

Currently there are two major reservoirs in the area, on the Otselic River in Whitney Point, the other on Ouleout Creek in East Sidney.

He said other recommendations might include programs of watershed management, raising the height of retaining walls, flood-proofing area buildings, zoning flood zones to ward off residential expansion, or constructing small dams.

McGarry advised city officials to form a citizens advisory group to work along with the Corps of Engineers while they draw up recommendations.

"There's a lot to be done to convince people something has to be done," he said.

FIGURE 28

Wilkes-Barre Times Leader

20 26 Jan 77 ★

3 Items Needed to Halt Local Flooding

A combination of three factors will provide protection for Wyoming Valley from a flood of the same magnitude of Agnes.

These factors were listed by Col. George K. Withers Jr. of the Baltimore District Army Corps of Engineers as the levees will pass a 100-year flood as was proved by their performance during the 1975 Eloise storm, the completion of the two upstream dams and the raising of the dikes by five feet.

Col. Withers was the principal speaker at the weekly luncheon meeting of Wilkes-Barre Rotary Club on Tuesday at Hotel Sterling.

The engineer said the two dams, Tioga-Hammond and Cowanesque, are scheduled to be completed by 1980, six months behind schedule due to a mud slide on Route 15 and poor construction weather.

Pending the approval of funds from Congress, Col. Withers said the earliest start for raising the levees another five feet would be in the mid-1980s He said the study also includes raising of bridges and railroads The price tag was placed by the colonel as $90 million

Col. Withers said there is not much prospect for any more impounding reservoirs upstream, stating he is writing a letter to New York State informing authorities five reservoirs proposed there will not be built He cited as reasons the cost factor, noting the benefits would not equal or exceed the costs, and violent public reaction to the projects.

Discussing dredging, the speaker told the Rotarians a preliminary and quick report was prepared last fall, indicating dredging was unjustified on the basis of economics involved He added the costs would greatly exceed the benefits However, the engineers will continue to study dredging as a means to provide flood protection.

Col. Withers stated that four factors are weighed by the Corps of Engineers when considering a project. He said these are engineering feasibility; economic justification, impact on the environment and the public's reaction.

Dike System History

The speaker gave a brief history of the dike system in Wyoming Valley and said it was designed to provide protection from a 1936 flood. He said that the system was constructed without benefit of subsurface investigation, no seepage control features in some areas and no study of soil mechanics He said in some areas the fill wasn't of the best type.

Despite this, he said the dikes have averted an estimated $728 million in damages. He said $600 million in damages was averted during the Eloise storm due to the successful system

The 1975 storm, when the river neared the top of the dikes, gave a number of indications that repairs had to be done He said seepage and boils were noted in Kingston, Wiklkes Barre and Hanover Township He said permanent repairs are being designed for Kingston and are expected to be completed in March with construction starting in late spring.

In Wilkes-Barre, permanent repairs are scheduled to begin in March at a trouble spot below Market Street

Plans are ready to construct a land seepage berm from near the Forty Fort Cemetery to one mile upstream, he said. The only thing holding up the project is land acquistion.

A discussion period followed A certificate of appreciation was presented to Col Withers by Samuel Bannan, president

WHAT WE DO TODAY — FLOOD CONTROL • POWER • RECREATION — FUTURE GENERATIONS WILL ENJOY TOMORROW

WEST BRANCH VALLEY FLOOD CONTROL ASS'N

CITIZENS ADVISORY GROUP TO
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SECA 303

REPRESENT THRU OFFICIAL RESOLUTION
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CLINTON COUNTY COMMISSIONERS
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LOGAN TOWNSHIP
BEECH CREEK TOWNSHIP
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BOROUGH OF JERSEY SHORE
BOROUGH OF MONTOURSVILLE
BOROUGH OF MUNCY
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IN UNION COUNTY
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LOCK HAVEN, PA 17745

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TREASURER - CAROLYN CANDOR
717-748-8319

January 7, 1976

Col. Robert S. McGarry
Corps of Engineers
District Engineer
Department of the Army
U. S. Army Engineering District
Baltimore, Md. 21233

Dear Col. McGarry:

The attached recommendations are presented to you for review and to possibly aid the Army Corps of Engineers in its overall approach to flooding in the West Branch.

These recommendations are the results of over two years of fact finding by the West Branch Valley Flood Control Association. The impact for this draft comes from twenty-five counties, cities, boroughs and townships plus numerous private citizens.

We find the area very apprehensive, and in a mood for immediate, direct action. The reason for this is the apparent increase in flood frequency and potential in Pennsylvania. We also find that because of the tremendous increase in value of land, personal property, etc. the economic impact of constant flooding has risen tremendously and becomes a major factor in the continued growth of the region.

We feel the attached recommendations are the basic needs of the area and fulfills part of our obligations to the Corps of Engineers as a citizen's advisory group. Your views will be appreciated and suggestions of any kind will be welcomed. We have also asked SRBC for their support and have copied them in on the recommendations.

Sincerely,

J. K. Sorgen
Co-Chairman

JKS/mkf

Attachment

FIGURE 30

West Branch Valley Flood Control Association
- Citizen's Advisory Group to the U.S. Army Corps of Engineers -
Recommendation on Flood Control for the West Branch of the Susquehanna

A. General Background

Immediately following the June, 1972 Agnes Flood, a group of interested citizens in the Lock Haven area held a public meeting attended by some 150 people to discuss flooding in the West Branch of the Susquehanna River. The outcome of this meeting was the formation of an Association dedicated to the control of the runoffs into the main stream of the river. The Association also advocates the use of soil conservation services, reforestation, channel improvements, and minor leveeing work in extreme low lying areas.

Since 1972 the Association has grown to where it now represents by official resolution 25 counties, cities, boroughs and townships, plus some 100 individual members. Representation extends from Clearfield County (the headwaters of the West Branch) to Sunbury (where the West Branch meets the North Branch to form the main stream of the Susquehanna). This area consists of approximately 250,000 residents.

Since the conception of the organization, representatives have traveled up and down the watershed speaking to any interested groups and to survey the feelings of the people. Since Agnes in 1972, we have experienced another flood of lesser magnitude called "Eloise" in September, 1975. The West Branch Valley Flood Control Association has completed its survey of the West Branch Valley and now submits the following recommendations to the Army Corps of Engineers, the Susquehanna River Basin Commission and other interested parties.

On December 3, 1974, the West Branch Valley Flood Control Association was asked by Col. Robert S. McGarry, Corps of Engineers, Baltimore District, to join with the Corps and act as a Citizens Advisory Committee to the Corps in their ongoing study of flood control measures for the West Branch. The Organization accepted and we, therefore, direct our recommendations to the Corps of Engineers.

B. Recommendations

(1) An addition of at least six (6) more dams of the Bush, Stevenson type in the headwaters above Lock Haven.

Example - Scootac Creek - Hyner Run - Young Womans Creek - Paddys Run - Clearfield Creek - Chest - Sinnemahoning.

$10,000,000 additional in 1975 at Lock Haven alone. Ref. Water Resources Development in Pennsylvania, Army Cops of Engineers 1973 - Communication from Wm. E. Trieschman, Chief of Planning, April 18, 1975.

(2) The completion, as soon as possible, of the feasibility of a major impoundment in the Keating area. This would be in conjunction with a system of smaller dams downstream to relieve local and flash flooding.

(3) Another impoundment in the Pine Creek Area for the Jersey Shore area.

(4) Impounding reservoirs in the Lycoming Creek - Loyalsock Creek, plus some stream management for relief from flooding of the Montoursville, Loyalsock Twp. areas.

(5) An impounding reservoir in the Muncy Creek Area.

(6) An impounding reservoir on White Deer Creek to provide flood control and a reserve water supply for that area.

(7) We strongly recommend clos cooperation between the Corps of Engineers and the Soil Conservation Service for impounding work on minor streams.

Example - A conservation dam on Fishing Creek which is in Clinton and Centre Counties is being studied by the Soil Conservation Service for relief of flooding in the Mill Hall area.

Streams south and east of the Jersey Shore area can be controlled by conservation dams whose prime purpose is to prevent damage from local flash flooding.

Example - Those conservation dams that now protect the City of Wellsboro called the Marsh Creek Project.

$3,000,000 saved in Wellsboro in the 1972 Agnes Flood. It was the only community in the area free of flood damage. Reference: U.S. Dept. of Agriculture, Soil Conservation Service, Harrisburg, PA, February, 1973.

C. Benefits of the Recommendation

Benefits from the recommendations submitted above would acrue to the entire region by preventing major flood crests from flowing downstream of the West Branch of the Susquehanna River.

(1) Communities would benefit from reserve water supplies.

(2) The entire population would benefit from further recreational facilities.

D. Conclusion

It has also become very evident that the great majority of residents in the West Branch Valley favor impounding reservoirs to protect all the area and minimize flood damages and reduce occurrences of flooding. Isolated local protection systems that only benefit a few to the detriment of the rest of the area are strongly opposed and will continue to be opposed very strenuously. The main reason for such strong opposition is that, because of the increasing frequency of flooding by both natural causes and man made causes, any investment of public funds must be made to obtain the maximum, beneficial return to the public on that investment. We feel that our recommendation, in conjunction with other flood plain management techniques meets such an investment standard.

Therefore, we strongly urge that the Corps of Engineers re-evaluate its position on local protection projects and move instead for an immediate program of regional control. The citizens and communities of the West Branch Valley have helped derrive and endorse the recommendation presented as evidenced by their attached endorsement. We urge you to listen, for only with strong local and regional support can any flood control measures be successfully implemented, as the lessons of Tocks Island, etc. have taught us.

TABLE 44

MAJOR PUBLIC WORKSHOPS AND MEETINGS

DATE	LOCATION	AREA TO WHICH MEETING PERTAINED
28 June 1976	Lock Haven, PA	West Branch of Susquehanna River
27 October 1976	Wilkes Barre, PA	Main Stem of Susquehanna River from Sayre, PA to Sunbury, PA and its tributaries
5 November 1976	Harrisburg, PA	Main stem of Susquehanna River from Sunbury, PA to Chesapeake Bay and its tributaries to include Juniata River Basin
1 December 1976	Corning, NY	Chemung River Basin to include those portions of the basin in northern Bradford and Tioga Counties, PA
2 December 1976	Binghamton, NY	North Branch of the Susquehanna River north of Sayre, PA and its tributaries

included discussion of basin-wide problems and alternatives as well as those relative to the particular area in which the meeting was conducted. Unlike the public meetings which consisted of formal presentations concerning all portions of the study by the planners and formal statements submitted by the public, the workshops were conducted in informal group discussions. Study planners headed the groups, each of which pertained to a particular aspect of the study. Ample time was alloted for the workshops to enable participants to take part in any or all of the discussion groups. This direct, informal contact assisted in established better paths of communication between the planners and the public and allowed the study team to become more involved in the community and to better appreciate the needs and concerns of the local public. Each of the meetings is discussed below.

28 June 1976: The Lock Haven public workshop pertained to the studies relative to the West Branch of the River Basin. Planners discussed the proposed additional studies of Keating to determine its hydroelectric power potential, studies of the structural and non-structural alternatives available to the citizens of the West Branch, and the results of the Lock Haven, Loyalsock, and Milton Local Flood Protection studies as they related to the Review Study.

A majority of the citizens attending the meetings appeared to be opposed to the Keating Dam and felt that additional studies should be done. They were told that additional studies were not a certainty but had been proposed and the support and views of both the State and local officials and the concerned citizens would have an important role in the decision-making process.

Several areas of concern were also raised about the proposed Lock Haven Flood Protection Project. Discussion centered around the effects of the project on downstream and adjacent communities, foundation conditions, and the ability of locals to pay their share of the initial construction cost and the operation and maintenance of the project. The study team members assured citizens that these concerns would be included in the study expected to be authorized for the Lock Haven Project.

Many citizens were interested in the reason for the lack of justification for the Milton Local Flood Protection Project. Planners explained in detail the benefit to cost ratio analysis process and the procedures utilized in evaluating the Milton project.

27 October 1976: The main topics of discussion at the Wilkes-Barre public meeting and workshops included dredging the Susquehanna River, reservoirs and flood protection projects, flood forecast and warning systems, and the Wyoming Valley Levee Raising study. Citizens were told that, even though any recommendation for regional alternatives were unlikely due to the low benefit to cost ratio, flood forecast and warning studies were continuing and further studies on the possibility of dredging the Susquehanna River were likely. Planners stated that Congress had approved further studies of the Wyoming Valley and discussed the project and outlined the recommendations for the project implementation.

Most of the participants expressed direct or indirect support for dredging the Susquehanna River as a mean of providing increased flood protection. They also stressed the need for additional upstream reservoirs. The general opinion was that something should be done for the entire basin.

15 November 1976: The Harrisburg public meeting and workshops addressed for the four Paxton Creek Channel Modifications and the five Harrisburg local flood protection alternative plans that were developed as the results of preliminary studies. The plans were described and the significant impacts of each alternative were presented. Planners distributed information sheets to participants as a means of providing a more comprehensive understanding of the alternatives. The public expressed dismay that Harrisburg was still without adequate flood protection so many years after the Agnes flood. Study planners explained the procedures the

DEPARTMENT OF THE ARI
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

NABPL-F 29 October 1976

TO ALL CONCERNED OFFICIALS AND THE PUBLIC

I would like to take this opportunity to invite all interested parties to attend a public meeting and workshop concerning the Corps of Engineers Susquehanna River Basin Flood Control Review Study. Because of the size of the Susquehanna River Basin, a number of meeting locations have been selected. Corning, New York and Binghamton, New York, are two of these. The portion of the river basin to be discussed at each of these meetings is shown on Figure 1.

The public workshop and meeting in Corning, New York, will be held on Wednesday, 1 December 1976 in the Goff Road Extension Center of Corning Community College, Goff Road, Corning, New York, from 2:00 p.m. to 5:00 p.m. and from 7:30 p.m. to 11:00 p.m., respectively. The Binghamton, New York, public workshop and meeting will be held on 2 December 1976 in the Classroom Wing, State University of New York at Binghamton, Vestal Parkway East, Binghamton, New York, from 2:45 p.m. to 5:00 p.m., and from 7:30 p.m. to 11:00 p.m., respectively.

The Susquehanna River Basin Flood Control Review Study is currently at a stage where identification has been made of potential Federal flood control projects which, at this time, appear to be feasible. It is important to inform and obtain feedback from the public so the concerns and issues raised can be incorporated into the next and final stage of the study. A final public meeting will be held at a later date to present the results of the study.

All those interested are urged to be present or represented at either or both of the afternoon workshops that will be conducted on an informal basis. Members of my staff will be available at these sessions to discuss details of our study activities concerning:

1. Reservoirs
2. Local Flood Protection
3. Flood Forecast and Warning
4. Tioga-Hammond and Cowanesque Lakes Projects (Corning meeting only)

These sessions will provide you with the best opportunity to have a free exchange of ideas, ask questions, and make comments on the various activities.

The evening public meetings will start with a brief overview of the various study results. Following this, it is planned to have individual discussion groups similar to the afternoon sessions for discussion of each of the flood control activities listed above. This will enable you to obtain details on a subject in which you have particular interest. The sessions will be formally reconvened after one hour of the group discussions. At that time, all parties will be afforded full opportunity to express their views and bring specific data on matters pertinent to the study. Statements should be supported by factual information insofar as possible.

During the evening meetings, oral statements will be heard, but for accuracy of record, it is suggested that all important facts and statements be submitted in writing. Written statements may be handed to the presiding officer at the meeting or mailed beforehand to the Corps of Engineers address above. Statements so mailed should indicate that they are in response to this announcement and for which of the two meetings they are intended. All statements, both oral and written, will become part of the Corps of Engineers official record of this study and will be made available for public examination. Supplementary comments submitted within two weeks following the meeting will also be included in the record of that meeting.

Please bring this announcement to the attention of anyone who may have not received a copy or anyone you may know who would be interested in this matter.

GK Withers

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Corps to Hold Meetings

WELLSBORO, PA., WEDNESDAY, NOVEMBER 24, 1976 15c PER CO[PY]

To Discuss Flood Control

Colonel George K. Withers, Baltimore District Engineer with the U.S. Army Corps of Engineers is urging local officials and citizens to attend one or both of the special meetings next Wednesday, December 1, 1976 at Corning, N.Y.

The purpose of the meetings is to discuss portions of the Susquehanna River Basin Flood Control Review Study which does affect Tioga County communities.

Withers states, "The Susquehanna River Basin Flood Control Review Study is currently at a stage where identification has been made of potential Federal flood control projects which, at this time, appear to be feasible. It is important to inform and obtain feedback from the public so the concerns and issues raised can be incorporated into the next and final stage of the study. A final public meeting will be held at a later date to present the results of the study."

It is expected that the study will be completed by September, 1977.

A public workshop will be held on December 1st in the Goff Road Extension Center of Corning Community College, Goff Road, Corning, N.Y. from 2 to 5 p.m. and a public meeting in the same location that evening from 7:30 to 11 p.m.

Members of Withers' staff will be at both the workshop and public meeting to discuss the details of study activities concerning reservoirs, local flood protection, flood forecast and warning and the Tioga-Hammond and Cowanesque Lakes Projects.

One of the phases of the Flood Control Review Study directly concerns five Tioga County communities.

It is stated that local alternatives have been evaluated for 45 communities located within the vicinity of the Corning meeting. After preliminary investigation, 36 were dropped from further consideration.

The eight communities and flood damage reduction alternatives for them are being studied in more detail. Of the eight communities, five are located in Tioga County.

Relocation, Floodproofing and-or Raising, flood damage reduction alternatives, are being considered for Potter Brook, Osceola, Westfield, Knoxville and Covington.

Channel Modification, another type of flood damage reduction alternative is being studied for Westfield also.

What are these methods?

Relocation

Relocation-Evacuation is according to the Corps another means of preventing flood damage. It consists of the permanent removal of buildings and other structures from a flood-vulnerable area. This generally involves purchasing the flood vulnerable land, demolishing or otherwise removing the buildings and other structures, cleaning up the debris and landscaping the area. New sites are provided for those structures which can be physically relocated. The necessary transportation facilities and utilities and such amenities as landscaping are also furnished.

When the buildings cannot be moved to a new site, they are purchased so that the owners can purchase replacement buildings out of the flood plain. This is costly, making this method of flood damage reduction attractive only where the extent of development is small and the area is frequently flooded.

Floodproofing

Floodproofing is a combination of structural changes and adjustments to properties subject to flooding, primarily for the reduction or elimination of flood damages. Although it is easier and cheaper to

(Continued on page 2)

Corps Meetings

(Continued from page 1)

apply it to new construction, floodproofing is also applicable to some existing buildings.

Raising

This measure consists of raising residential type structures so that the first floor level is above the flood level. The majority of the damages to the structure from a smaller flood are prevented. However, a flood of greater magnitude than the design flood would still cause damages to both structure and contents. A maximum raising of six feet was evaluated as part of this study.

Channel Modification

Channel modification consists of a number of different techniques used singly or in combination. These are the removal of material from the channel to provide an enlarged area for the flow of the river, straightening of the channel, and clearing of overbank areas to allow for more efficient flow conditions. These modifications allow a given volume of flow to pass a given area at a reduced flood height.

Channel modification is most effective on small streams because the increase in channel capacity is more easily achieved. Generally, this method provides a relatively low degree of flood protection. Sediment deposits must be removed periodically to maintain the channel dimensions and the effectiveness of the project.

Tioga County Land Use Administrator Chester P. Bailey; Norman Johnson, Executive Director of the Tioga County Soil Conservation District; George Gillespie, President of the Upper Tioga Watershed, and several Township supervisors from Covington and the Cowanesque Valley are planning to attend the December 1st meeting.

Bailey stated that he is attending because of his concern over how much the Corps intends to get involved in flood plain management at the local level.

Figure 32

Corps is required to follow in conducting a study and stated that studies of the alternatives would continue.

1 December 1976: The Corning meeting included discussions of the Corps plan formulation process, the lack of justification for major reservoirs in the area, non-structural approaches to local flood protection, the flood forecast and warning system being developed for the Corning area, and the Tioga-Hammond and Cowanesque Dams. Citizens were told that prelimary studies indicated that no Federal projects in the Corning area were economically feasible but some areas were being evaluated.

Residents attending the meetings expressed considerable interest in basin-wide and local self-help flood forecast and warning systems. Planners stated that work was continuing on the formulation of a flood forecast and warning system.

2 December 1976: The Binghamton public meeting and workshops presented an overview of the study and identified the alternatives which required further study. Printed material prepared and distributed by the study team provided information concerning the evaluation process, benefit to cost ratios and environmental concerns of each alternative.

Participants of the meeting displayed considerable adverse reaction to the possibility of locating five reservoirs in the region. Many of the attendees felt that small upstream dams would be the most environmentally, ecologically, economically and socially sound method of flood control. Planners stated that the five reservoirs were still under study and that the public views would be considered as the studies progressed.

At each of the above meetings, participants were told that future public workshops and meetings would be conducted during various phases of the study. However, as the study progressed, it became apparent that a majority of the areas under study could not satisfy the requirements of economic feasibility necessary to obtain authorization for further studies. In view of the negative results of the studies in these areas, planners felt that additional large-scale public meetings and workshops would be of no value or interest to the public. Therefore, the additonal meetings which had been projected for these areas were eliminated from the public involvement program.

Continuing Public Involvement

As a result of the Review Study, additional studies are warranted for the following areas: Williamsport and South Williamsport, Pennsylvania, and Binghamton N.Y. and the Towns of Erwin and Conklin and Kirkwood, New York. Meetings have been held with representatives of State and local governments for each area to give the planners an opportunity to discuss with the representatives the study background and the reasons for and various aspects of the additional studies and to determine the extent of state and local interest in the continuation of the studies. The meetings resulted in the Corps receiving assurances of State and local interest and cooperation from the representatives. The following shows the date of each meeting and the area to which it pertained:

a. 19 April 1979 - Williamsport and South Williamsport, Pennsylvania

b. 8 August 1979 - Binghamton, New York

c. 12 September 1979 - Erwin, New York

d. 8 November 1979 - Conklin and Kirkwood, New York

Corps planners are continuing studies of these areas. A separate study is being conducted for each area and a public involvement program for each will be developed and implemented as necessary to insure that the public is kept informed of the study and its progress and is given the opportunity to express their veiws and concerns during the planning process.

COORDINATION

When the areas that warranted further study were identified, meetings were held with representatives of State and local governments for each area to discuss with them the study background and the reasons for and various aspects of the additional studies. At these meetings the representatives from State and local governments indicated their interest in the studies and their willingness to cooperate in their conduct. Separate studies will be concucted for each area and coordination will be effected with Federal, State, and local government representatives and local citizens as the studies progress.

The draft report was coordinated with Federal, State and regional agencies and with those communites where additional studies are warranted to obtain their views. Copies of the coordination correspondence are included in Appendix 1 and comments have been incorporated in the body of the report.

Conclusions

Prior reports and studies have been reviewed to determine if there are improvements which, if implemented, wouid reduce the flood damages in the Susquehanna River Basin. Various structural and nonstructural measures were evaluated to determine their applicability and were then combined into alternative plans designed to solve the flooding and other water resource problems in the Basin. Technical, economic, and environmental criteria were applied to determine the best plans in meeting the needs of the Basin.

The details of the investigations conducted in this study was only carried to the level necessary to establish preliminary project feasibility. Additional studies are required to firmly establish feasibility. Additional studies are required to firmly establish feasibility. This process has lead to the identification of six potential projects shown on Figure 33 and listed in Table 45.

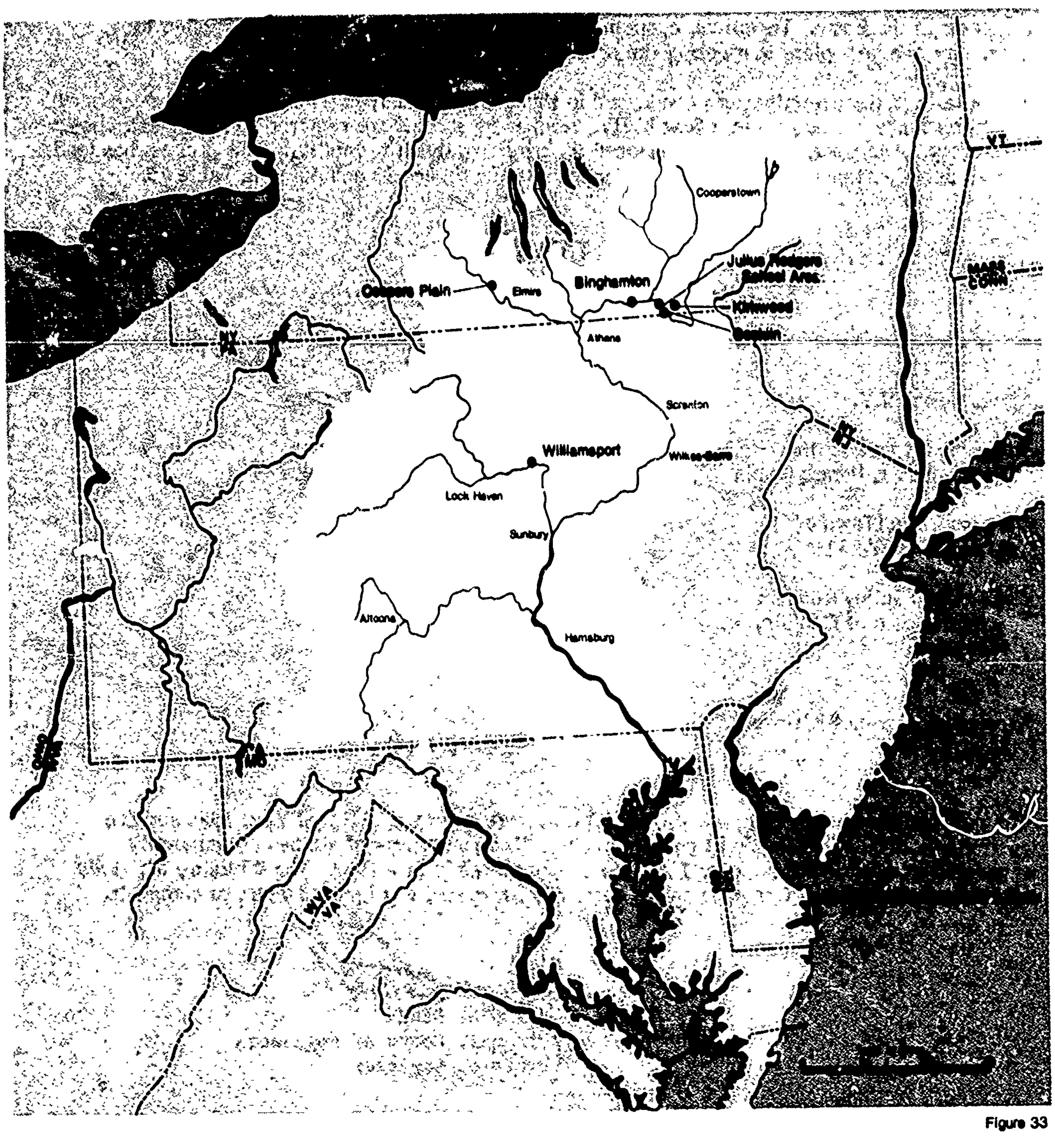
TABLE 45

PROJECTS WARRANTING FURTHER STUDY

Location	Type of Project
Binghamton, N.Y.	Raising Existing Project
Williamsport and South Williamsport, Pennsylvania	Raising Existing Project
Coopers Plain (Town of Erwin, New York)	Nonstructural
Conklin and Julius Rodgers School (Town of Conklin, New York)	Nonstructural
Kirkwood, (Town of Kirkwood, New York)	Nonstructural

The detailed studies for Binghamton, New York, were initiated in Fiscal Year 1980 and are currently scheduled for completion in mid-1982. The nonstructural studies are currently scheduled to start in Fiscal Year 1981 and be completed in late 1982. The Williamsport study has been authorized by Congress and is currently estimated to require 3 years to complete.

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer



Cooperstown
Julius Rodgers School Area
Binghamton
Elmira
Athens
Kirkwood
Scranton
Williamsport
Lock Haven
Sunbury
Altoona
Harrisburg
VT.
MASS
CONN
NY
PA
W.VA
VA
MD

Figure 33

appendix 1

coordination correspondence

Appendix 1 - Coordination Correspondence

Table of Contents

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:

NABPL-F

15 JUL 1980

Honorable Clifford L. Jones
Secretary
Pennsylvania Department of
Environmental Resources
P.O. Box 1467
Harrisburg, Pennsylvania 17120

Dear Mr. Jones:

Inclosed for your review and comment is the draft report on the Susquehanna River Basin Flood Control Review Study. This report is being coordinated with appropriate Federal, State, and regional agencies. A summary of the study will be distributed to the general public in early August 1980 to give the study results a wide circulation throughout the Basin.

The study is a basinwide effort with emphasis on identifying locations where Federal involvement is feasible in providing solutions to flooding problems. The results indicate that there are very few potentially feasible projects. The study has found that additional study is warranted for increasing the level of protection at the existing Federal projects in Binghamton, New York, and Williamsport and South Williamsport, Pennsylvania. It was also found that additional study is warranted of nonstructural measures in the Towns of Erwin, Conklin, and Kirkwood, New York.

Parts of the study were conducted at various times over a period of years. The results presented in the report, therefore, reflect the data available at the time the analyses were conducted. It is not believed that conditions have altered sufficiently to change any conclusions reached in the study.

Comments on this document should be received in this office no later than 15 August 1980 so they may be incorporated into the final report. Should you have questions concerning the report, please contact me or have a member of your staff contact Mr. Harry Kitch, Project Manager, at (301) 962-2530 or (FTS) 922-2530.

Sincerely yours,

1 Incl
As stated

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:

Identical letter sent to:

Honorable Robert F. Flacke
Commissioner
New York State Department of Environmental Conservation
50 Wolf Road
Albany, NY 12233

Honorable James B. Coulter
Secretary
Department of Natural Resources
Tawes State Office Building
Annapolis, MD 21401

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P O BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF

NABPL-F

Mr. Robert J. Bielo
Executive Director
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, Pennsylvania 17102

Dear Mr. Bielo:

Inclosed for your review and comment is the draft report on the Susquehanna River Basin Flood Control Review Study. This report is being coordinated with appropriate Federal, State, and regional agencies. A summary of the study, in the form of a pamphlet, will be distributed to the general public in early August 1980 to give the study results a wide circulation throughout the Basin.

The study is a basinwide effort with emphasis on identifying locations where Federal involvement is feasible in providing solutions to flooding problems. The results indicate that there are very few potentially feasible projects. The study has found that additional study is warranted for increasing the level of protection at the existing Federal projects in Binghamton, New York, and Williamsport and South Williamsport, Pennsylvania. It was also found that additional study is warranted of nonstructural measures in the Towns of Erwin, Conklin, and Kirkwood, New York.

Parts of the study were conducted at various times over a period of years. The results presented in the report, therefore, reflect the data available at the time the analyses were conducted. It is not believed that conditions have altered sufficiently to change any conclusions reached in the study. The January 1979 Flood Forecast and Warning System Evaluation (FF&W) and its findings have been summarized in the report. Any changes to the FF&W system since the completion of the 1979 report could be accomplished by the use of a supplement to the published report rather than in the Review Study report as suggested in your 30 October 1979 letter.

The Baltimore District has made significant progress in the areas recommended for action in the FF&W report and highlighted in your letter of 30 October 1979.

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:
NABPL-F

15 JUL 1980

Mr. Robert J. Bielo

The Flood Plain Management Services Branch in cooperation with the Commission prepared River Stage Forecast maps for the Village of Owego, Tioga County, New York; the Bloomsburg area of Columbia County, Pennsylvania; and the Borough of Milton, Pennsylvania. These maps show approximate areas of flooding which correspond to river stage forecasts by the National Weather Service. A similar map is being prepared for Lycoming Creek in Lycoming County, Pennsylvania. In addition, assistance is being provided to the Town of Bloomsburg, Mifflin County, and the City of Lock Haven in flood warning and evacuation planning.

The District has also established four new river gages and new snow survey stations for the Tioga-Hammond and Cowanesque projects. The District is participating in a North Atlantic Division-wide review of the existing water control data collection and analysis system which will evaluate system performance.

I commend the Commission for its assumption of the leadership role in the continuing evaluation of the flood forecast and warning system. The Review Study report will not be forwarded to Congress but will be released to the public as an information document. The Commission, therefore, with its State-Federal position is in the best position to pursue the recommendations of the FF&W evaluation.

Comments on the Review Study report should be received in this office no later than 15 August 1980 so they may be incorporated into the final report. Should you have questions concerning the report, please contact me or have a member of your staff contact Mr. Harry Kitch, Project Manager, at (301) 962-2531 or (FTS) 922-2531.

Sincerely,

1 Incl
As stated

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Copy furnished:
Mr. Patrick Delaney
Federal Commissioner
Susquehanna River Basin Commission
Department of the Interior Building
Room 6246
Washington, DC 20240

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P O BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF

NABPL-F

15 July 1980

Mr. Richard Stanton
Regional Director
National Park Service
143 South 3rd Street
Philadelphia, Pennsylvania 19106

Dear Mr. Stanton:

Inclosed for your review and comment is the draft report on the Susquehanna River Basin Flood Control Review Study. This report is being coordinated with appropriate Federal, State, and regional agencies. A summary of the study will be distributed to the general public in early August 1980 to give the study results a wide circulation throughout the Basin.

The study is a basinwide effort with emphasis on identifying locations where Federal involvement is feasible in providing solutions to flooding problems. The results indicate that there are very few potentially feasible projects. The study has found that additional study is warranted for increasing the level of protection at the existing Federal projects in Binghamton, New York, and Williamsport and South Williamsport, Pennsylvania. It was also found that additional study is warranted of nonstructural measures in the Towns of Erwin, Conklin, and Kirkwood, New York.

Parts of the study were conducted at various times over a period of years. The results presented in the report, therefore, reflect the data available at the time the analyses were conducted. It is not believed that conditions have altered sufficiently to change any conclusions reached in the study.

Comments on this document should be received in this office no later than 15 August 1980 so they may be incorporated into the final report. Should you have questions concerning the report, please contact Mr. Harry Kitch, Project Manager, at (301) 962-2531 or (FTS) 922-2531.

Sincerely,

1 Incl
As stated

WILLIAM E. TRIESCHMAN, Jr.
Chief, Planning Division

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:

Identical letter sent to (con't):

Mr. Emmett Mallison
Supervisor
Town of Erwin
Town Hall - West Water Street
Painted Post, New York 14870

Mr. George S. Archie, Jr.
Supervisor
Town of Conklin
Box 10E - R.D. #2
Conklin, New York 13748

Mr. Joseph A. Griffin
Supervisor
Town of Kirkwood
R.D. #2 - Crescent Drive
Kirkwood, New York 13795

Honorable Alfred J. Libous
Mayor
City of Binghamton
4th Floor, City Hall
Governmental Building
Binghamton, New York 13901

Mr. Jack J. Schramm
Regional Administrator
Region III
Environmental Protection Agency
6th and Walnut Streets
Philadelphia, Pennsylvania 19106

Regional Administrator
Region II
Environmental Protection Agency
26 Federal Plaza, Room 1009
New York, New York 10007

Mr. Graham T. Munkittrick
State Conservationist
Soil Conservation Service, U.S.D.A.
Box 985, Federal Square Station
Harrisburg, Pennsylvania 17108

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:

Identical letter sent to (con't):

Regional Engineer
FERC Regional Office
22 Federal Plaza, 22nd Floor
New York, New York 10007

Regional Hydrologist
Eastern Region
NOAA National Weather Service
585 Stewart Avenue
Garden City, New York 11530

Regional Hydrologist
Geological Survey
National Center
Mail Stop 433
12201 Sunrise Valley Drive
Reston, Virginia 22092

Director
SEDA - Council of Governments
R.D. 1
Lewisburg, Pennsylvania 17837

Honorable R. David Frey
Mayor
Borough of South Williamsport
City Hall
329 W. 7th Street
South Williamsport, Pennsylvania 17701

Honorable Daniel P. Kirby
Mayor
City of Williamsport
City Hall
454 Pine Street
Williamsport, Pennsylvania 17701

Maryland State Clearinghouse
Department of State Planning
301 West Preston Street
Baltimore, Maryland 21201 (Incl - 10 cys)

New York State Clearinghouse
New York State Division of the
Budget
State Capital
Albany, New York 12224 (Incl - 10 cys)

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:

Identical letter sent to (con't):

Regional Engineer
FERC Regional Office
22 Federal Plaza, 22nd Floor
New York, New York 10007

Regional Hydrologist
Eastern Region
NOAA National Weather Service
585 Stewart Avenue
Garden City, New York 11530

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New York State Division of the
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State Capital
Albany, New York 12224 (Incl - copy)

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:

Identical letter sent to (con't):

State Conservationist
Soil Conservation Service, U.S.D.A.
Hartwick Building
Room 522
4321 Hartwick Road
College Park, Maryland 20740

State Conservationist
Soil Conservation Service, U.S.D.A.
U.S. Courthouse and Federal Building
100 South Clinton Street
Room 771
Syracuse, New York 13260

Chief
Office of Environmental Project Review
United States Department of Interior
Washington, D.C. 20240

Mr. Paul Hamilton
Supervisor
U.S. Fish and Wildlife Service
Cortland Field Office
100 Grange Place, Room 202
Cortland, New York 13045

Mr. Glenn Kinser
Supervisor
U.S. Fish and Wildlife Service
Annapolis Field Office
1825-B Virginia Street
Annapolis, Maryland 21401

Mr. Charles Kulp
Supervisor
U.S. Fish and Wildlife Service
State College Field Office
P.O. Box 438
State College, Pennsylvania 16801

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
6TH AND WALNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

AUG 5 1980

Mr. William E. Trieschman, Jr.
Chief, Planning Division
Baltimore District
Corps of Engineers
P.O. Box 1715
Baltimore, Maryland 21203

Dear Mr. Trieschman:

We have completed our review of the draft Susquehanna River Basin Flood Control Review Study.

We believe the document presents a clear view of the problem and adequately discusses alternatives. We also concur that the six potential projects resulting from this study warrant further investigation. If any of these projects should be considered for authorization in the future we would appreciate the opportunity of reviewing the individual study, the environmental assessment or a completely developed Environmental Impact Statement if one is required.

We thank you for the opportunity of coordinating with you on this study and look forward to cooperation in the future.

Sincerely yours,

John R. Pomponio
Chief
EIS & Wetlands Review Section

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
112 West Foster Avenue
State College, PA 16801

August 5, 1980

Colonel James W. Peck
Baltimore District
Corps of Engineers
P.O. Box 1715
Baltimore, MD 21203

Dear Colonel Peck:

This letter responds to a request dated July 15, 1980, by William E. Trieschman of your staff to review the Draft Susquehanna River Basin Study. The study was authorized by several resolutions of the Committee on Public Works of the House of Representatives, the latest being October 12, 1972. Our comments are submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat 401, as amended; 16 U.S.C. 661 et seq.).

The document adequately describes existing fish and wildlife resources within the Susquehanna River Basin for the scope and purpose of this study. There is one error on page 32, paragraph 6 which should be corrected in the final document. The bog turtle, Clemmys muhlenbergi, is not a federally listed endangered species. The Pennsylvania Fish Commission has listed the bog turtle as endangered in Pennsylvania.

The study identified three sites for structural improvements and three for nonstructural plans. As indicated in the study, nonstructural flood control measures will have little adverse impact and will preserve natural fish and wildlife habitat. The structural alternatives consist of raising the height of existing levees and extending them into new areas. Project plans are still too general to determine what impacts will result from levee construction.

We will evaluate the environmental impacts and make recommendations for each structural measure as detailed plans are developed.

Sincerely yours,

For

Asst. Supervisor

Charles J. Kulp
Field Supervisor

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION II
26 FEDERAL PLAZA
NEW YORK NEW YORK 10278

[illegible] 1980

Mr. William E. Trieschman, Jr.
Chief, Planning Division
Baltimore District, Corps of Engineers
Department of the Army
P.O. Box 1715
Baltimore, Maryland 21203

Dear Mr. Trieschman:

This is in response to your request for our comments on the draft report for the Susquehanna River Basin Flood Control Study.

The study was undertaken to determine where Federal involvement to provide flood relief is feasible. The results indicate that additional study is warranted for the existing Federal project in Binghamton and for nonstructural measures in the towns of Erwin, Conklin and Kirkwood, all in New York.

We have no criticism of the results of the study and are pleased to see that nonstructural controls, rather than structural measures, are recommended to reduce flood damages. We look forward to reviewing an EIS, if one is required, on the Binghamton project.

As the preponderance of the Susquehanna basin lies within the jurisdiction of Region III of the Environmental Protection Agency, a copy of the study should also be sent to them for review.

Thank you for the opportunity to review the document.

Sincerely yours,

Conrad Simon
Director
Water Division

United States Department of the Interior

NATIONAL PARK SERVICE

North Atlantic Region
15 State Street
Boston, Massachusetts 02109

IN REPLY REFER TO
L7619
NAR(PEC)

Mr. William E. Trieschman, Jr.
Chief, Planning Division
Department of the Army
Baltimore District, Corps of Engineers
P.O. Box 1715
Baltimore, Maryland 21203

Dear Mr. Trieschman:

This is in response to your letter of July 15, by Harold Nelson, requesting our review and comments.

We have reviewed the draft report (August, 1980) on the Susquehanna River Basin Flood Control Review Study and find no conflicts with interests of the National Park Service. We note that five of the improvement projects (one structural, and four non-structural) are in New York State, hence within our regional jurisdiction. While there are no existing or proposed units of the National Park System to be affected by any of these projects we do encourage careful consideration for the development of recreational resource values and adequate protection of cultural resource values. We understand each of these projects will be given further detailed study whereby recreation and cultural resource protection aspects can be properly considered. The Heritage Conservation and Recreation Service, Philadelphia office, will have much to contribute in the review of such studies.

You should understand that this commentary pertains only to National Park Service outlooks and in no way predisposes any position of the Department of the Interior or other bureaus therein.

Sincerely yours,

Richard L. Stanton

Richard L. Stanton
Regional Director

Year of the Visitor

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES
POST OFFICE BOX 2063
HARRISBURG, PENNSYLVANIA 17120

The Secretary
717-787-2814

August 12, 1980

In reply refer to:
RM-R
F 70:0

Colonel James W. Peck
District Engineer
Baltimore District, Corps of Engineers
P. O. Box 1715
Baltimore, Maryland 21203

Dear Colonel Peck:

In response to your letter of July 15, 1980 our Bureau of Resources Programming staff has reviewed your draft report entitled "Susquehanna River Basin Flood Control Review Study". We note that after many years of study effort and reviewing hundreds of local flood protection projects, it is the conclusion of this report that it may be possible to justify raising the Williamsport levee, subject to additional study. No other solution, structural or non-structural, is recommended in the Pennsylvania portion of the Basin. We, therefore, must strongly object to the recommendations of this report as failing to propose viable flood damage reduction solutions for the Susquehanna River Basin.

This study was initiated after Hurricane Agnes caused approximately 3.5 billion dollars of damage in Pennsylvania with widespread loss of life. We feel that it was the intent of the Committee on Public Works in authorizing the study that a review of the 1970 Susquehanna River Basin Study should be undertaken to determine what could be recommended to help reduce flood damage. The language in the authorization such as "specifically to determine the advisability of adopting further improvement for flood control and allied purposes in view of the heavy damages and loss of life caused by the hurricane flood of June 1972" and also "with a view to providing a comprehensive plan for the development of the water and related land resources of the Susquehanna Basin - with particular emphasis on flood control" makes it clear that the Committee on Public Works was visualizing recommendations that would ameliorate the threat of flooding. We feel that if this report would have been given to the same Committee a few weeks after the authorization, it would not be acceptable. Positive means of further reducing flood damage are <u>not</u> recommended.

The original Susquehanna Basin Study called for a number of major impoundments and numerous smaller dams under the SCS 566 Program. Since acquisition of land for flood retention is now difficult, it would seem that local flood protection would be an alternative. As it appears in the "Draft", even without flood retention impoundments, local flood protection projects can not be justified.

We feel that the problem of not being able to recommend projects lies in the study methodology adopted by the Federal Government. The inability to use environmental and social benefits unless economic benefits can be shown first; the use of flood damage data that is possibly outdated; the inability to apply the loss of market value in the

damage equation; and certain roots of the methodology, when applied in a rigid nonflexible fashion, have apparently caused the surprising determination that there are no justified local flood control projects in the Susquehanna River Basin - except two subject to further study (one in Pennsylvania and one in New York State).

Unless the basic planning methodology is revised, it would appear that the Corps has no program for local flood protection in the Susquehanna River Basin. This position seems untenable, and we would recommend that guidelines should be developed which will correct any deficiencies in the methodology.

We are particularly distressed by the lack of nonstructural recommendations in the report conclusions. One is led to believe that the report is intended to discuss remaining structural possibilities in the Basin. Pennsylvania is currently directing its efforts toward stormwater and floodplain management in order to reduce flood flows and gradually eliminate unnecessary construction in the flood zone. These programs, in combination with other nonstructural measures such as early warning techniques, will work to alleviate Pennsylvania's flood damage costs. We find the lack of emphasis on such nonstructural measures in the report to be intolerable.

A specific comment is that there is no mention of the current Harrisburg, Wilkes-Barre, Milton or Lock Haven studies in Table 38 or elsewhere in the document. This should be corrected. Table 38 also lists Amity Hall, PA as being on the West Bank Susquehanna River. This should also be corrected.

The Department has always been more than willing to cooperate and assist the Corps in planning and developing flood damage reduction programs. While it is true that considerable progress and work has been done in this area, it is incorrect to assume that the job is finished particularly in light of the recent Agnes and Eloise Flood Damages. We must work together to continually attack the flooding problem in the Susquehanna River Basin. An ongoing program analyzing both structural and nonstructural measures is the only rational way of adequately finding long range solutions.

We hope our observations are helpful to you in further assessing your program needs.

Sincerely,

Clifford L. Jones

CLIFFORD L. JONES

United States Department of Agriculture
Soil Conservation Service
P. O. Box 985
Federal Square Staton
Harrisburg, Pennsylvania 17108

August 13, 1980

Mr. William E. Trieschman, Jr., Chief
Planning Division
Department of the Army
Baltimore District, Corps of Engineers
P. O. Box 1715
Baltimore, Maryland 21203

Dear Mr. Trieschman:

We have reviewed the draft report on the Susquehanna River Basin Flood Control Review Study and offer the following comments:

1. Page 18 - Flood Control Dams - add Nescopeck Creek Watershed, Luzerne County, Pa.

2. Page 111 - eighth paragraph - change "ten watersheds" to eleven watersheds.

3. Page 113 - Figure 19 - delete Bull Run, Union County, and add Spring Creek, Dauphin County.

4. Page 114 - Table 31 - Add Spring Creek Watershed, Dauphin County, Pennsylvania.

If you have any questions concerning these comments, contact Mr. Willie L. Ruffin, River Basin Staff Leader, at (717) 782-2298, or (FTS) 590-2298.

Sincerely,

Graham T. Munkittrick
State Conservationist

United States Department of Agriculture
Soil Conservation Service
U. S. Courthouse and Federal Building
100 South Clinton Street, Room 771
Syracuse, New York 13260

August 14, 1980

Mr. William E. Trieschman, Jr.
Chief, Planning Division
Department of the Army
Baltimore District, Corps of Engineers
P.O. Box 1715
Baltimore, Maryland 21203

Dear Mr. Trieschman:

We have reviewed the August 1980 draft report on the Susquehanna River Basin Flood Control Review Study, prepared by the Baltimore District, U. S. Army Corps of Engineers.

The following comments are provided for your use:

Page 18 - List of Watershed Flood Control Dams

The projects listed could be better titled "Watershed Flood Prevention" and "Watershed Protection" projects. These projects usually consist of dams and other measures such as dikes, channels, land treatment, etc.

Please note that the Newtown-Hoffman Creek Watershed is in Chemung and Schuyler Counties, New York (not Schuyker County).

Page 53 - 4th paragraph

The authority listed at the end of this sentence should be PL 74-46 not PL 7-446.

Page 57 - Figure 13

In New York, the following is a more current listing of the status of Upstream Watershed Projects in New York:

Marsh Ditch - Construction Completed
Little Choconut, Finch Hollow and Trout Brook - Construction Completed
Patterson, Brixius and Grey Creek - Construction Completed

Page 111 - Small Upstream Reservoirs - 3rd paragraph

The Soil Conservation Service in New York has been authorized to do planning on the Brandywine Creek Watershed in Broome County.

Mr. William E. Trieschman, Jr. August 14, 1980

Page 111 - Small Upstream Reservoirs - 4th paragraph and
Page 113 - Figure 19

In New York, the applications have been withdrawn by the applicant sponsors on the following watersheds:

Aldrich Brook Watershed
Charlotte Creek Watershed
Otego Creek Watershed
Fuller Hollow Watershed

Planning has been terminated on the Upper Otselic Creek Watershed.

Page 114 - Table 31 - Watershed Projects - SCS Application Pending

Same comments as above.

We appreciate the opportunity to review and comment on this study.

Sincerely,

for Karl Reinhardt
Paul A. Dodd
State Conservationist

MARYLAND
DEPARTMENT OF STATE PLANNING
301 W. PRESTON STREET
BALTIMORE, MARYLAND 21201

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

August 19, 1980

Mr. William E. Trieschman
Chief, Planning Division
Department of the Army
PO Box 1715
Baltimore, Maryland 21203

SUBJECT: PROJECT NOTIFICATION AND REVIEW

Applicant: U.S. Army Corps of Engineers

Project: Draft Report - Susquehanna River Basin Flood Control Review Study

State Clearinghouse Control Number: 81-7-81

State Clearinghouse Contact: James McConnaughhay (383-2467)

Dear Mr. Trieschman:

The State Clearinghouse has reviewed the above project. In accordance with the procedures established by the Office of Management and Budget Circular A-95, the State Clearinghouse received comments from the Department of Natural Resources, Department of Economic and Community Development, including their Historical Trust section, Office of Environmental Programs, Department of Transportation, Department of Agriculture, Harford County and our staff noting that the project is not inconsistent with their plans and programs. The Environmental Programs Office also suggested that the study consider downstream use and the effects of storms upon downstream use.

As a result of the review, it has been determined that the proposed project is not inconsistent with State plans, programs and objectives as of this date.

Sincerely,

James W. McConnaughhay
Director, State Clearinghouse

cc: William Zenton/R.S. Lynch/Michael Pugh/Stephanie O'Hara/Lowell Frederick/
Clyde Pyers/Henry Silbermann/William Eichbaum/Comprehensive

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Robert F. Flacke
Commissioner

DIVISION OF WATER
FLOOD PROTECTION BUREAU

September 19, 1980

Colonel James W. Peck
District Engineer
US Department of the Army
Baltimore District, Corps of Engineers
P. O. Box 1715
Baltimore, Maryland 21203

Dear Colonel Peck:

This is in reference to the draft report on the Susquehanna River Basin Flood Control Review Study forwarded to Commissioner Flacke with your letter of July 15, 1980.

Staff of this Department have reviewed the report and are, in general, pleased with your findings. We encourage the Corps of Engineers to undertake those additional studies identified where Federal involvement is feasible in providing solutions to flooding problems at the earliest possible time.

There are, however, several items which we feel need clarification or additional information. The first is the findings on Page 184 that a non-structural project appears feasible in the Town of Kirkwood. The Kirkwood project, however, is not included in Table 54, Page 215, as one of those warranting further study. In Table 50, on Page 181, a 210-year flood frequency protection plan for Unadilla is listed as having a BCR of 0.90. We would appreciate receiving additional details on your work at this location, since the project appears to be very nearly economically feasible.

We are concerned with the report that out of the numerous flood problem areas in the basin, only six locations appear to qualify for assistance under the Corps program. We believe that this indicates a comprehensive analysis of Federal flood control policies and programs is needed so that some level of assistance can be provided to other areas. We

support current Federal legislative proposals, such as Section 221 of HR-4788, which authorizes the Corps to undertake a nationwide study of flood problems and effectiveness of existing programs, with a view towards making recommendations for modifications to present laws and policies. We would favor a pilot study of this type in the Susquehanna River Basin which would be accomplished wholly or in partnership with the Susquehanna River Basin Commission.

Sincerely,

Robert A. Cook
Assistant Director for Water
Management Subdividion

SEDA
COUNCIL OF GOVERNMENTS

SEDA-COUNCIL OF GOVERNMENTS

TIMBERHAVEN RD 1 • LEWISBURG, PENNSYLVANIA 17837 • 717 524 4491

September 24, 1980

Colonel James Peck
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1715
Baltimore, MD 21203

Dear Colonel Peck:

SUBJECT: Susquehanna River Basin Flood Control Review Study
(Draft, August 1980)

The Board of Directors at SEDA-Council of Governments has closely followed the developments of the Susquehanna River Basin Flood Control Review Study through our Flood Hazard Reduction Advisory Committee. We offer these comments on the August 1980 draft report. Staff comments pertaining to technical aspects of the study have already been forwarded to Mr. Harry Kitch.

1. The results of the review study remain disappointing, but not discouraging. The disappointment stems from the study conclusions, i.e. raising the levee system at Williamsport-South Williamsport, Pennsylvania, and at Binghamton, New York, and several small relocation-flood proofing projects in New York State. It seems unthinkable that a study commissioned in responding to the magnitude of the damages caused by Tropical Storm Agnes would produce so few potential projects. We are not discouraged, however, for the results of this study have now demonstrated the certain need to approach flood hazard mitigation from a comprehensive multi-agency standpoint--a goal we are striving to achieve in cooperation with the Susquehanna River Basin Commission. The Baltimore District is a member of the Task Force that is putting the program together.

   The President called for comprehensive and coordinated flood hazard mitigation programs in his letter to the Senate and House transmitting "A Unified National Program for Flood Plain Management" (January 8, 1980). The report was prepared by the U.S. Water Resources Council, of which the Department of the Army is a member. With this clear call from the President and the bleak picture of significant progress through traditional Corps programs, assistance from the Baltimore District must come through different means, several of which are listed in this letter.

2. The Flood Control Review Study did note that improvements are needed in the flood forecasting and warning systems serving the Susquehanna River Basin.

Not stated was the important role the Corps can play in these improvements. You are presently assisting in the operational and maintenance costs for satellite platforms transmitting hydrologic data from gauging sites in the Basin. Another opportunity to improve the operational basis of Corps' projects and further the overall Corps' flood damage reduction mission will soon be available.

The National Weather Service and the Appalachian Regional Commission are providing equipment and technical assistance to enhance the county flood warning systems. Improved communication reliability, computer capability, and automatic radio reporting rain gauges are three forms of equipment scheduled for installation.

In order to design an effective rainfall reporting system that is useful for small watersheds and larger basins, a combination of new radio reporting rain gauges, volunteer observers and existing gauges are necessary. One drawback to the implementation of an effective system is the requirement that counties pay full operational and maintenance costs. Recognizing that this financial burden on counties severely constrains system development--and may even eliminate it altogether, the Pennsylvania Legislature is now considering a bill to cost-share operational and maintenance expenses with counties.

We believe that the Baltimore District should also share in these expenses. For further explanation of this matter, the Corps' role, and use of information generated, we suggest contacting SEDA-COG Board member, Clinton County Commissioner Dan Reinhold (717-748-3201).

3. SEDA-COG and member counties and communities have been successfully working with the Flood Plain Services Management Branch of the Baltimore District. The study does not mention these services and the very real need for their expansion.

4. It should be noted that any proposed impoundment in the Pine Creek Valley at Cammel will be strongly opposed by residents of the valley.

5. We are not absolutely convinced that the addition of hydropower facilities at existing reservoirs will not constrain the flood control capabilities. We wish to clearly state that a reduction in flood control capability of existing reservoirs is unacceptable.

We trust the comments will assist the Baltimore District in its vital role.

Sincerely,

Ronald Clyde Shearer

Ronald Clyde Shearer, President
SEDA-COG Board of Directors

RCS/dfs

RESOLUTION NO. 80-12

A RESOLUTION by the Susquehanna River Basin Commission recognizing the accomplishments and responding to the serious limitations of the recently completed U.S. Army Corps of Engineers Susquehanna River Basin Flood Control Review Study initiated in December, 1974.

WHEREAS, preventing the loss of life and significantly reducing future property damage from floods within the basin through an integrated system of structural flood control and nonstructural flood plain management measures are objectives of the Susquehanna River Basin Commission's Comprehensive Plan for Management & Development of the Water Resources of the Susquehanna River Basin; and

WHEREAS, the Susquehanna River Basin sustains average annual flood damages of $50,000,000; and

WHEREAS, there are over 1,000 communities in the basin that continue to be vulnerable to flooding and sustain frequent flood damages.

NOW THEREFORE BE IT RESOLVED THAT:

1. The Susquehanna River Basin Commission recognizes and supports implementation of the Susquehanna River Basin Flood Control Review Study recommendations and findings as follows:

a) Raising the level of flood protection for existing local flood control projects at Binghamton, New York and at Williamsport-South Williamsport, Pennsylvania;

b) Development of detailed nonstructural plans for the Broome County, New York communities of Conklin, Kirkwood and the Julius Rodgers School Area, and the community of Coopers Plain, Steuben County, New York;

AND, commends the Baltimore District and the Flood Control Review Study for:

a) Providing technical and financial assistance for the conduct of an Evaluation of the Basin's Flood Forecasting and Warning System;

b) For undertaking a study of the feasibility of floodproofing existing residential, commercial and industrial structures.

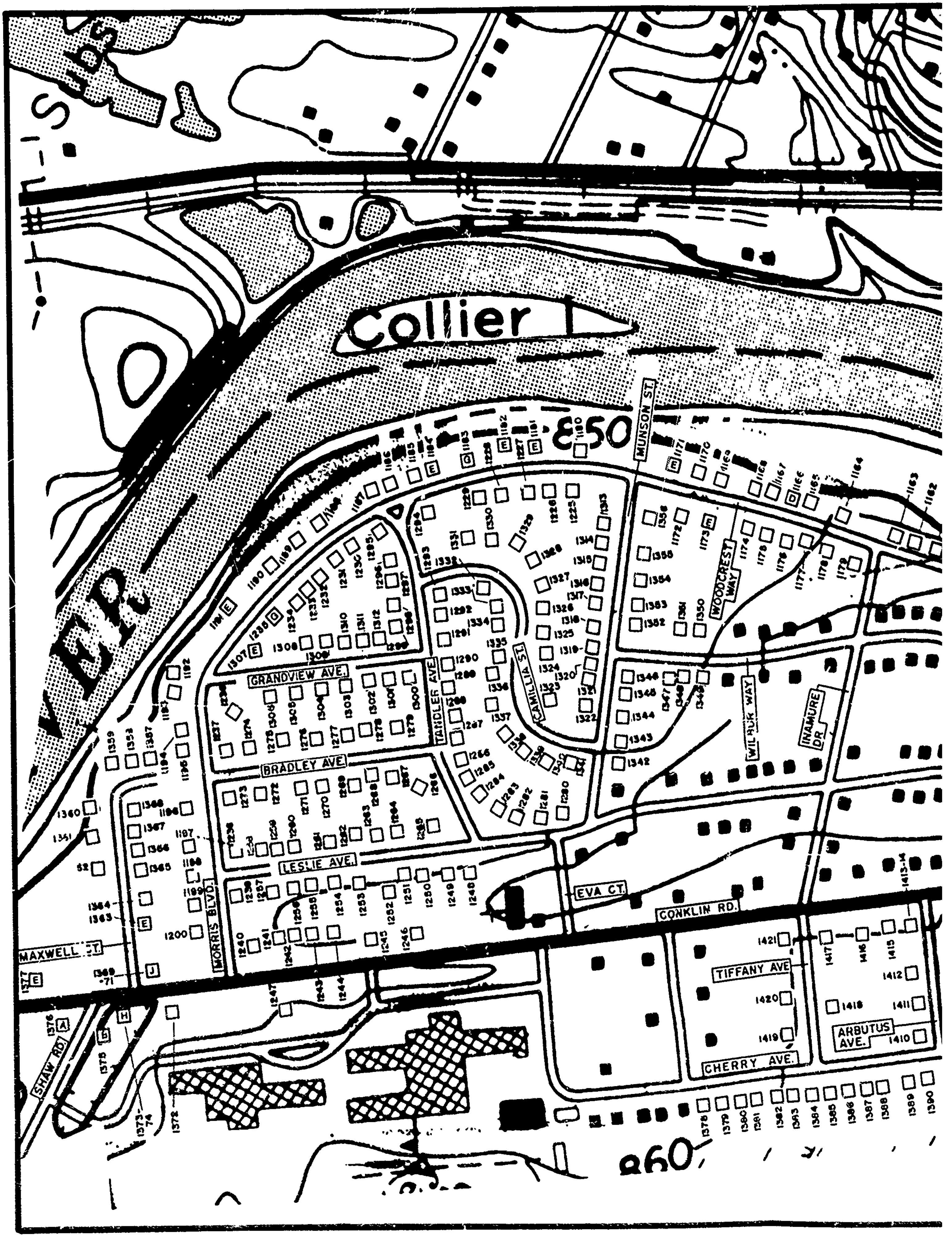
2. The Susquehanna River Basin Commission, in close cooperation with the signatory states and the Corps of Engineers shall:

a) Determine the legislative needs essential to permit increased flexibility in Federal policies as they relate to the determination of the economic feasibility of structural and nonstructural flood damage reduction measures and submit such findings to the members of the Congressional Delegations of the signatory states;

b) Identify the existing Federal programs that can contribute through grants and other actions to the implementation of flood damage reduction measures needed by flood prone communities in the basin.

October 15, 1980
Date

Chairman



Collier
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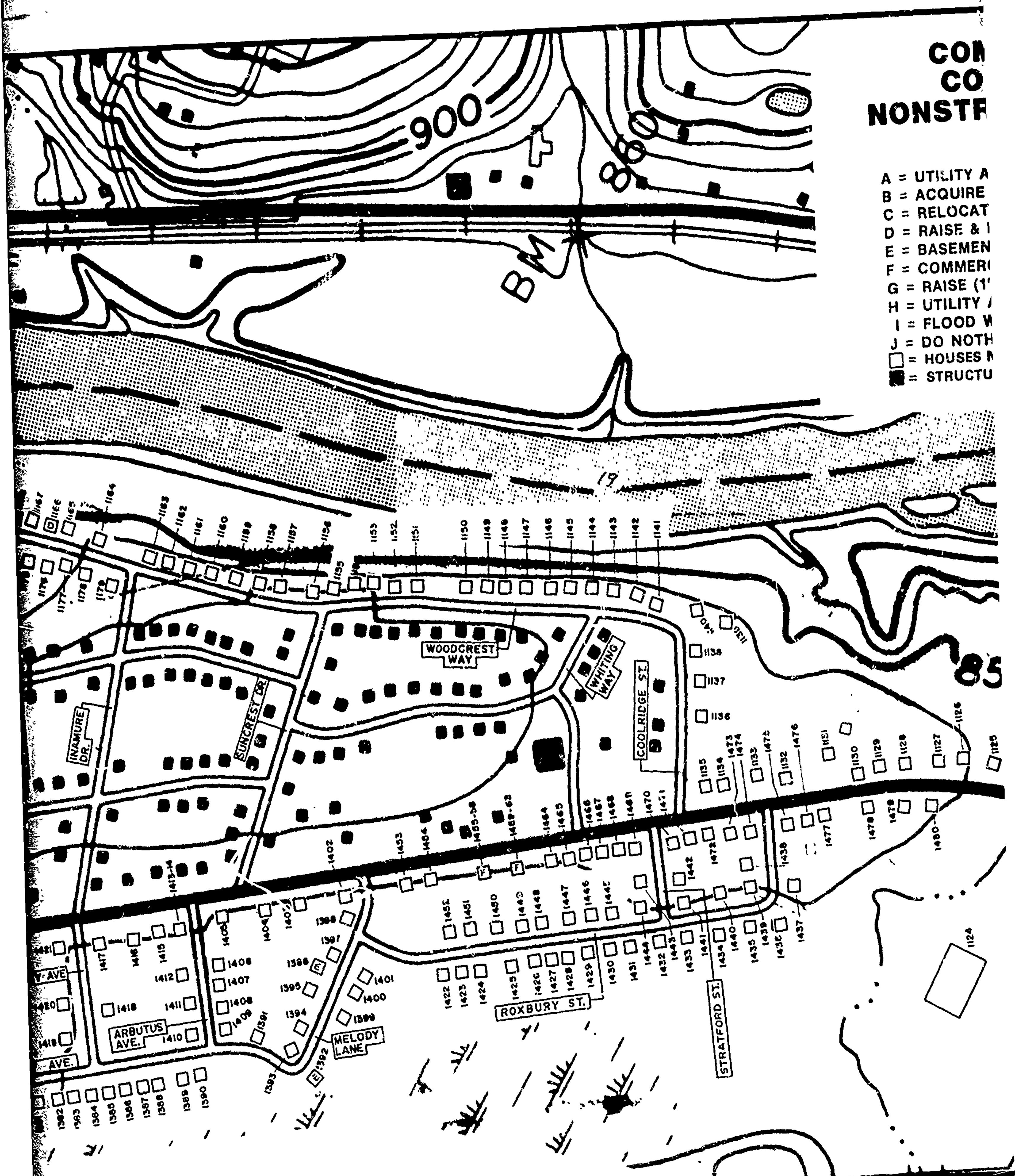
WOODCREST WAY
GRANDVIEW AVE.
TANDLER AVE
CAMILLIA ST.
BRADLEY AVE.
LESLIE AVE.
MORRIS BLVD.
MAXWELL CT.
EVA CT.
CONKLIN RD.
WILHUR WAY
INAMURE DR.
TIFFANY AVE
ARBUTUS AVE.
CHERRY AVE.
SHAW RD.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A = UTILITY A
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C = RELOCAT
D = RAISE & I
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G = RAISE (1'
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= STRUCTU
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COOLRIDGE ST.
SUNCREST DR.
INAMURE DR.
ARBUTUS AVE.
MELODY LANE
ROXBURY ST.
STRATFORD ST.

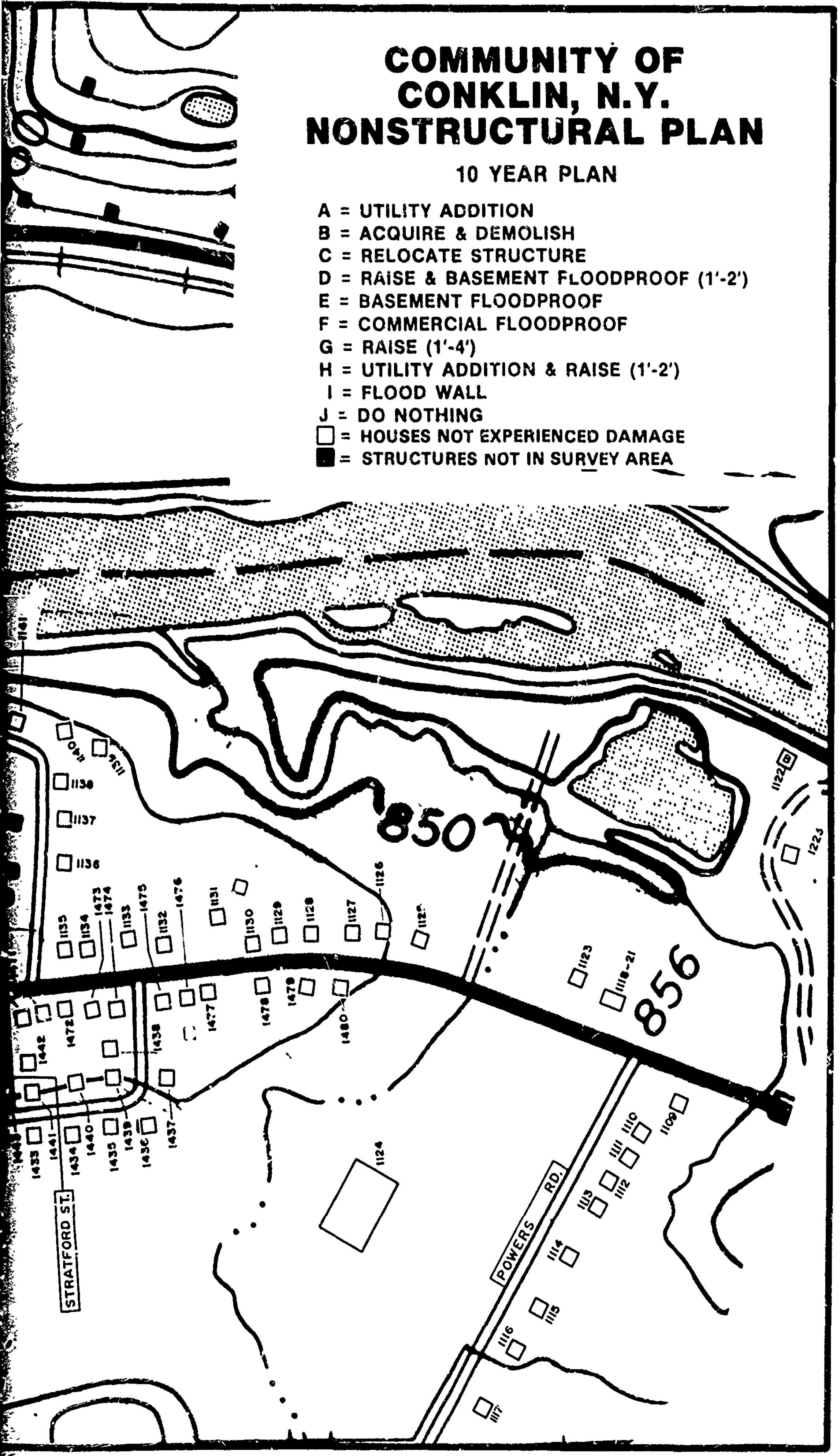
COMMUNITY OF
CONKLIN, N.Y.
NONSTRUCTURAL PLAN
10 YEAR PLAN
A = UTILITY ADDITION
B = ACQUIRE & DEMOLISH
C = RELOCATE STRUCTURE
D = RAISE & BASEMENT FLOODPROOF (1'-2')
E = BASEMENT FLOODPROOF
F = COMMERCIAL FLOODPROOF
G = RAISE (1'-4')
H = UTILITY ADDITION & RAISE (1'-2')
I = FLOOD WALL
J = DO NOTHING
□ = HOUSES NOT EXPERIENCED DAMAGE
■ = STRUCTURES NOT IN SURVEY AREA
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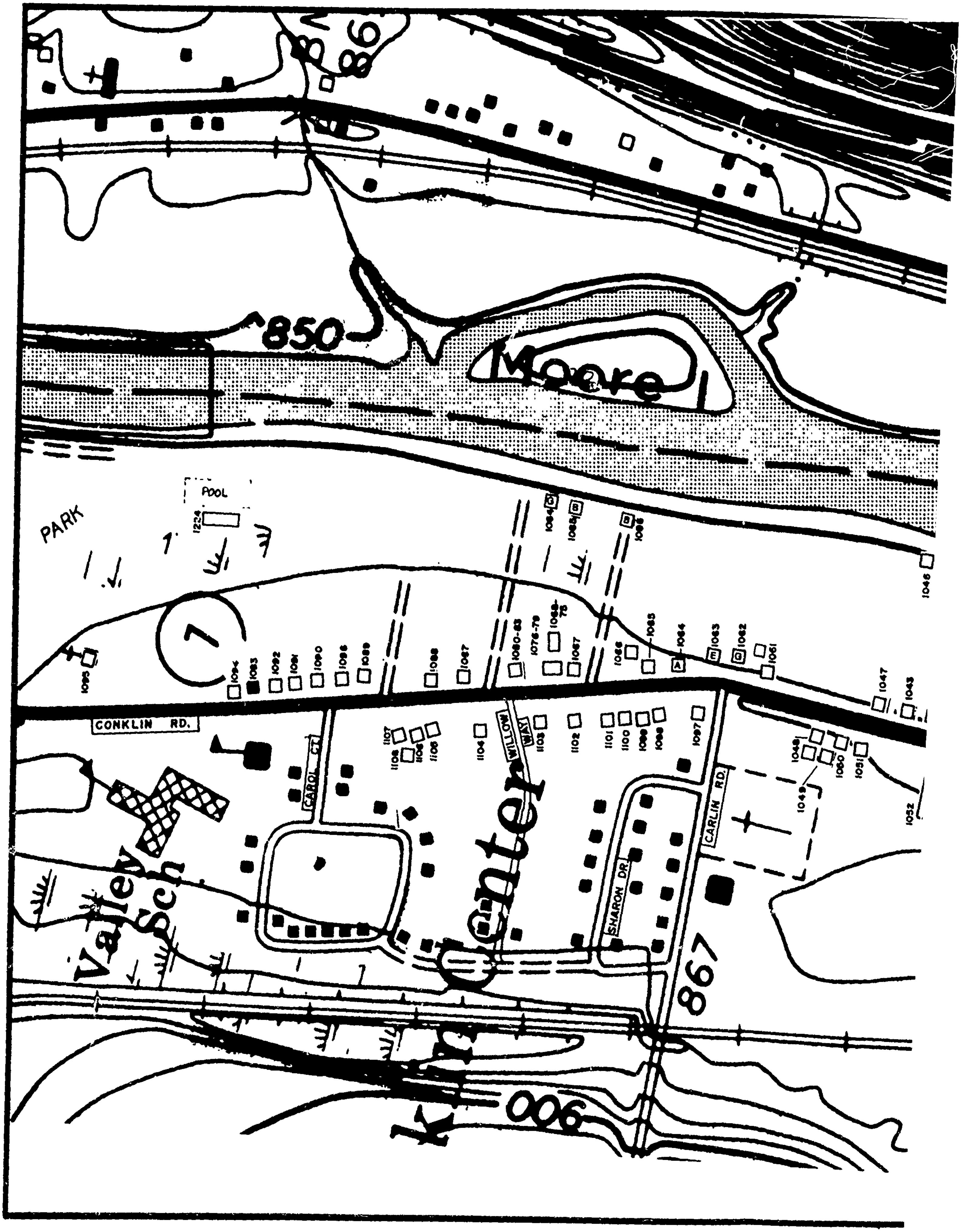
Plate 1



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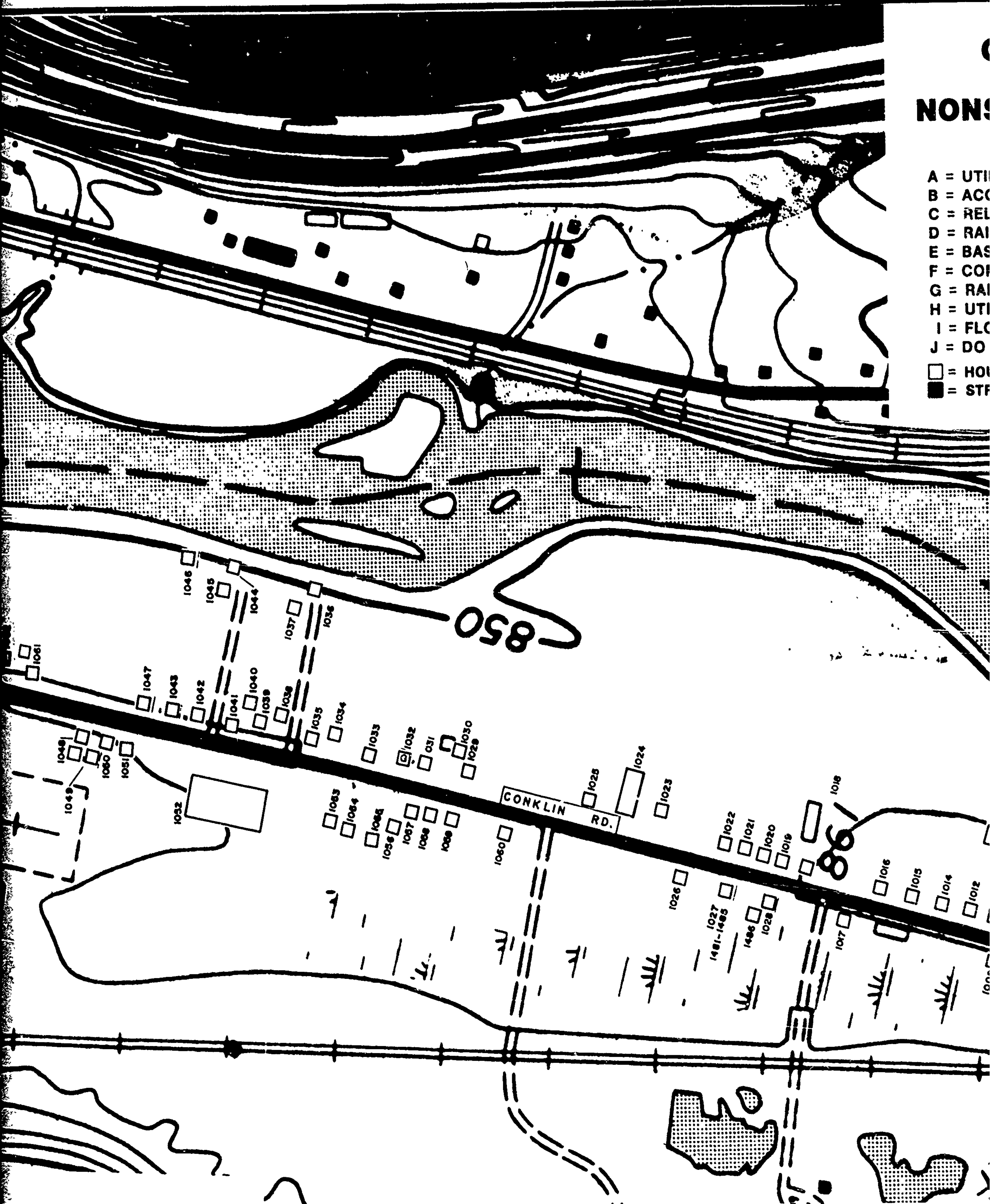
Moore
POOL
PARK
1224
CONKLIN RD.
CAROL CT.
WILLOW WAY
SHARON DR.
CARLIN RD.
Valley
Sch
Center
867
900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B = ACC
C = REL
D = RAI
E = BAS
F = COF
G = RAI
H = UTI
I = FLC
J = DO
= HOU
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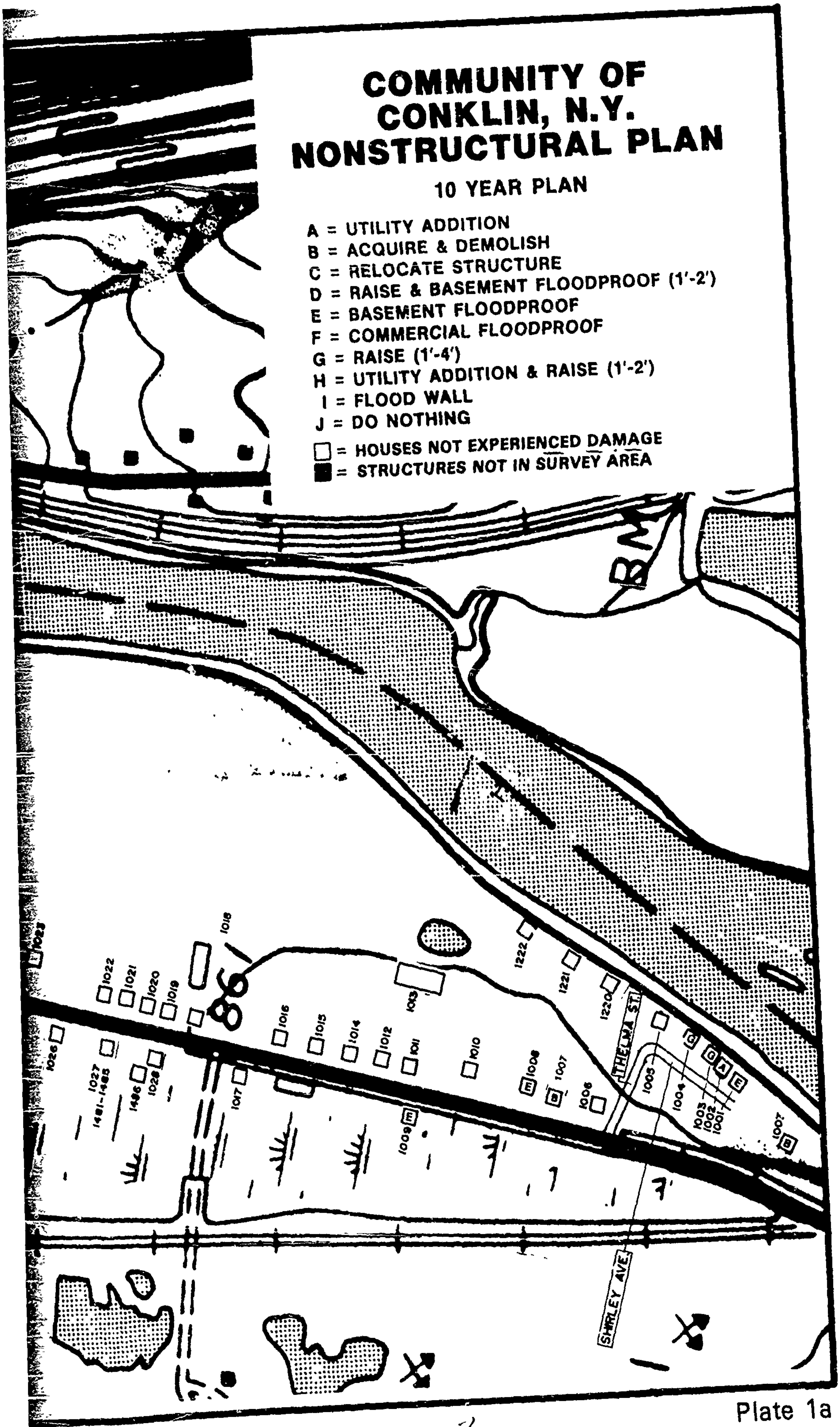
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H = UTILITY ADDITION & RAISE (1'-2')
I = FLOOD WALL
J = DO NOTHING
= HOUSES NOT EXPERIENCED DAMAGE
= STRUCTURES NOT IN SURVEY AREA
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SHIRLEY AVE.
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1221
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1008
1007
1006
1005
1004
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1001
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1026
1027
1028
1486

Plate 1a


ROUTE 81
KIRKWOOD
TRAILER PARK
KIRKWOOD, NY
CONKLIN

COMMUNITY OF
KIRKWOOD, N.Y.
NONSTRUCTURAL PLA
33 YEAR PLAN
RELOCATION OF TRAIL

Pla

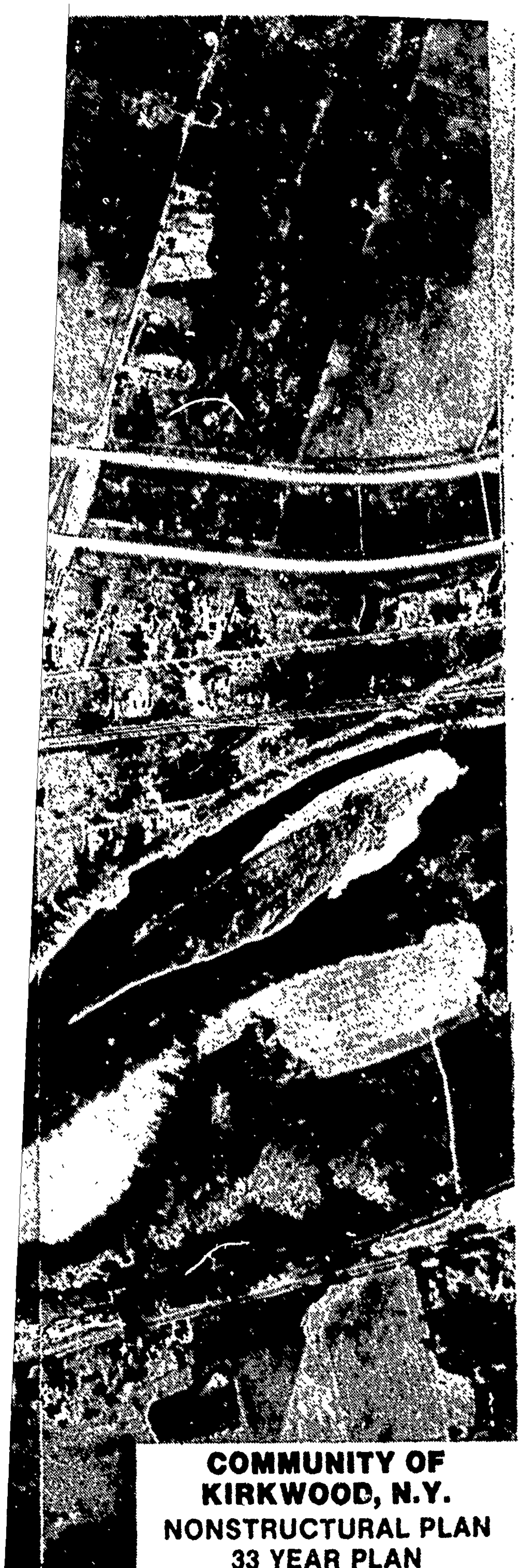
COMMUNITY OF
KIRKWOOD, N.Y.
NONSTRUCTURAL PLAN
33 YEAR PLAN
RELOCATION OF TRAILERS

Plate 2

1050
GEE ST.
BARBARA AVE.
TRAILER PARK
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2274
2265
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2222
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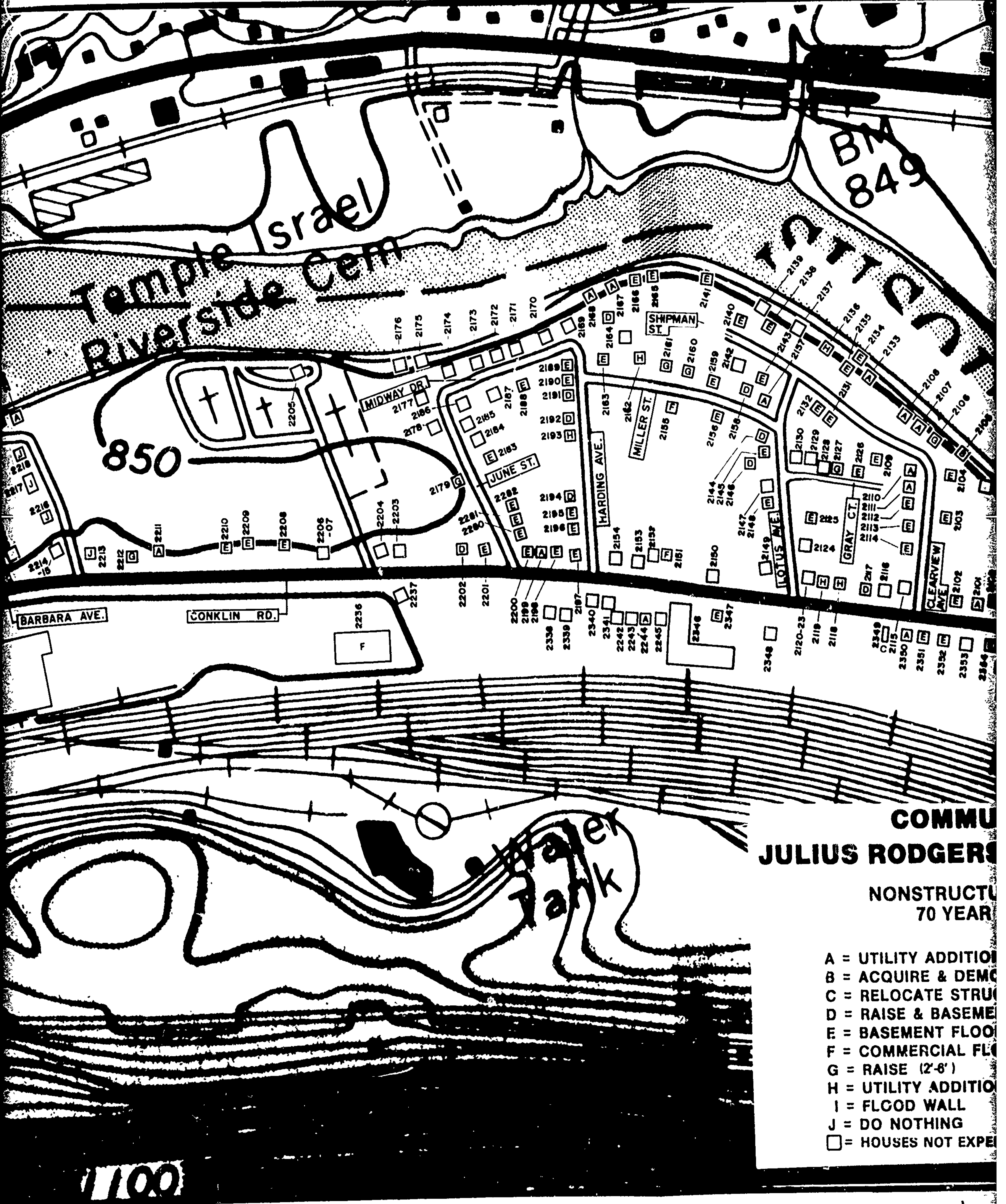
2214
-15
2213
2212



Temple Israel
Riverside Cem
BM 849
850
MIDWAY DR.
JUNE ST.
SHIPMAN ST.
HARDING AVE.
MILLER ST.
LOTUS AVE.
GRAY CT.
CLEARVIEW AVE
BARBARA AVE.
CONKLIN RD.
Park
1100
COMMU
JULIUS RODGERS
NONSTRUCTU
70 YEAR
A = UTILITY ADDITIO
B = ACQUIRE & DEMO
C = RELOCATE STRU
D = RAISE & BASEME
E = BASEMENT FLOO
F = COMMERCIAL FL
G = RAISE (2'-6')
H = UTILITY ADDITIO
I = FLOOD WALL
J = DO NOTHING
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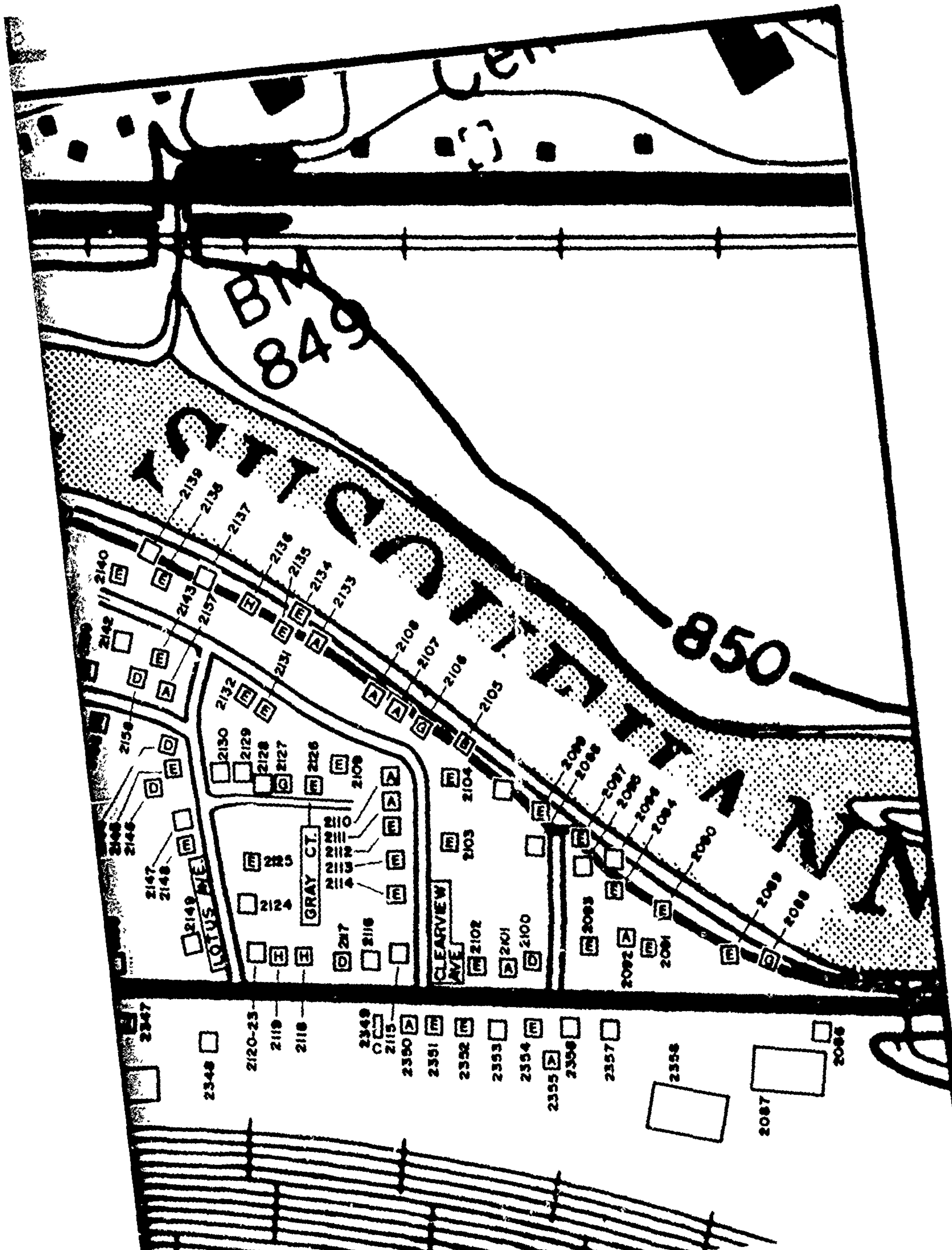
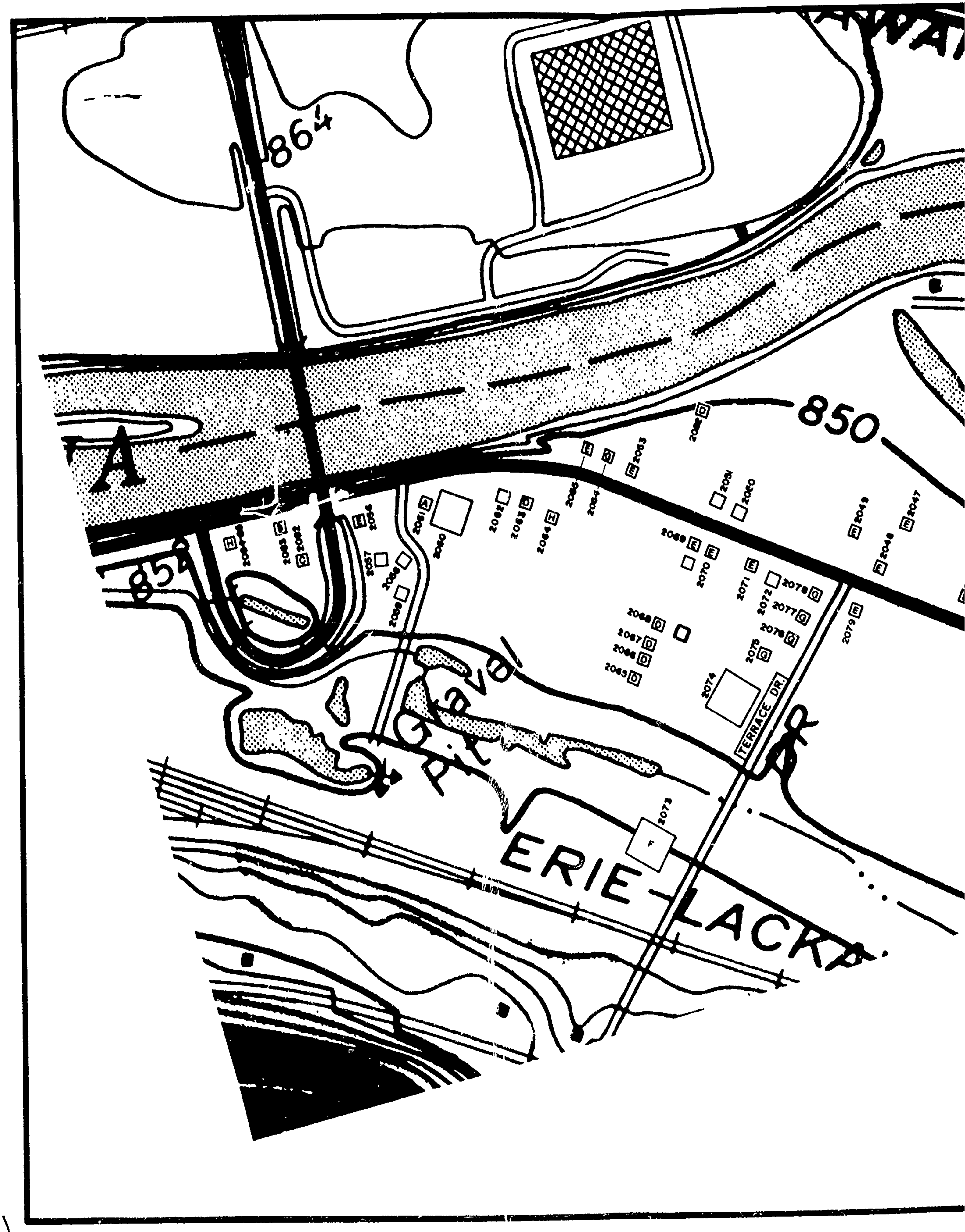


COMMUNITY OF JULIUS RODGERS SCHOOL AREA, NY

NONSTRUCTURAL PLAN
70 YEAR PLAN

A = UTILITY ADDITION
B = ACQUIRE & DEMOLISH
C = RELOCATE STRUCTURE
D = RAISE & BASEMENT FLOODPROOF (2'-6')
E = BASEMENT FLOODPROOF
F = COMMERCIAL FLOODPROOF
G = RAISE (2'-6')
H = UTILITY ADDITION & RAISE (2'-8')
I = FLOOD WALL
J = DO NOTHING
☐ = HOUSES NOT EXPERIENCED DAMAGE



864
850
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TERRACE DR.
ERIE-LACKA
Gravel Pit
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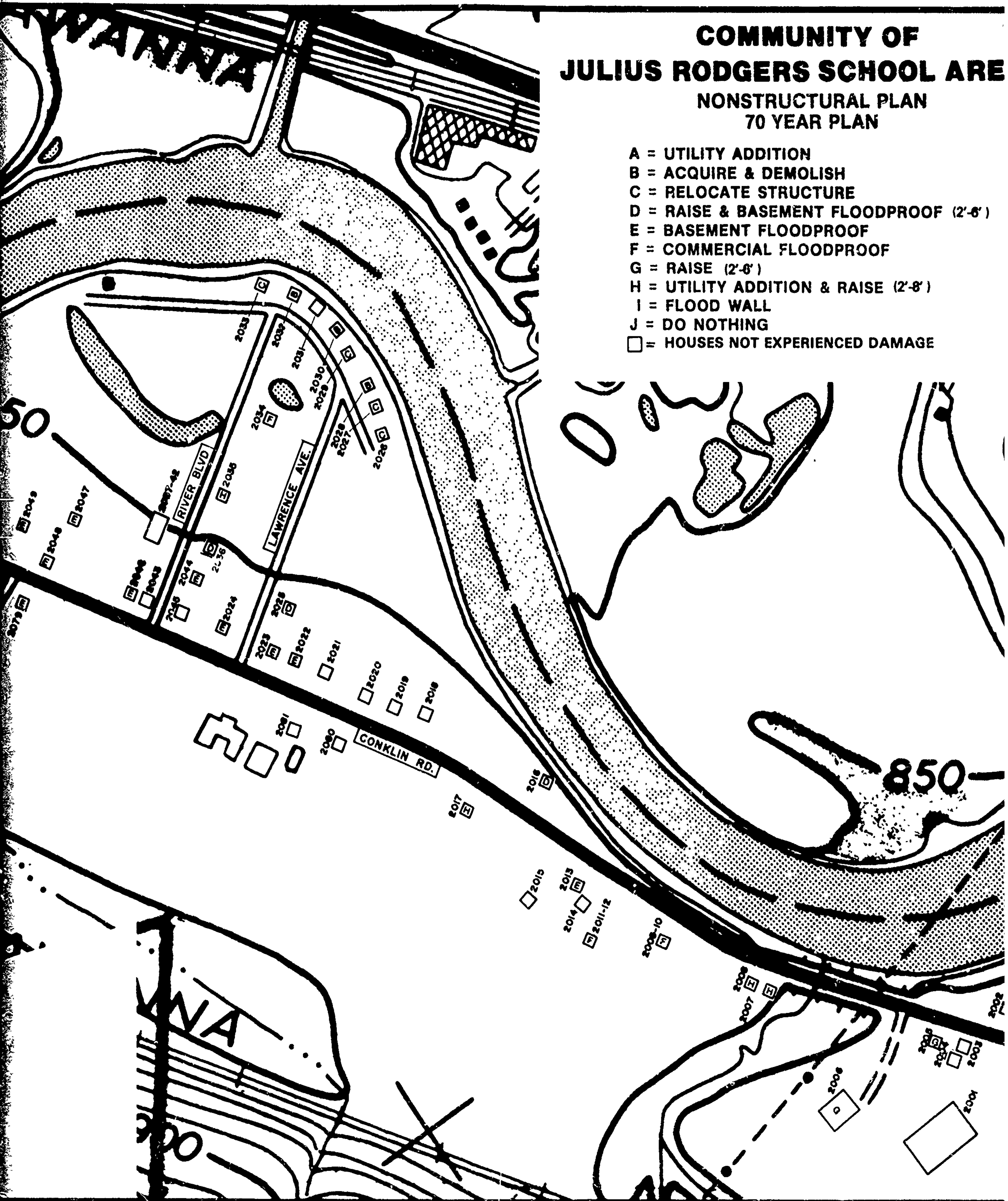
2048
2049
2050
2051
2074
2075
2079


COMMUNITY OF
JULIUS RODGERS SCHOOL ARE
NONSTRUCTURAL PLAN
70 YEAR PLAN
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G = RAISE (2'-6')
H = UTILITY ADDITION & RAISE (2'-8')
I = FLOOD WALL
J = DO NOTHING
= HOUSES NOT EXPERIENCED DAMAGE
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LAWRENCE AVE.
CONKLIN RD.
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2

IUNITY OF

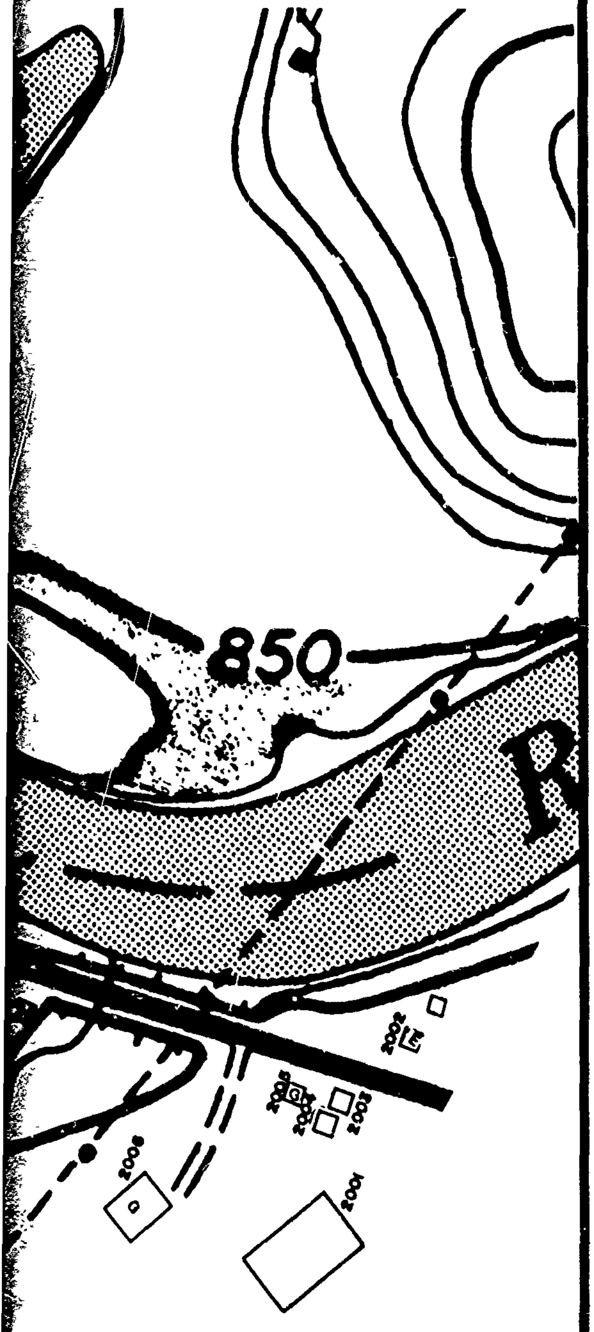
RS SCHOOL AREA,NY

IUCTURAL PLAN
YEAR PLAN

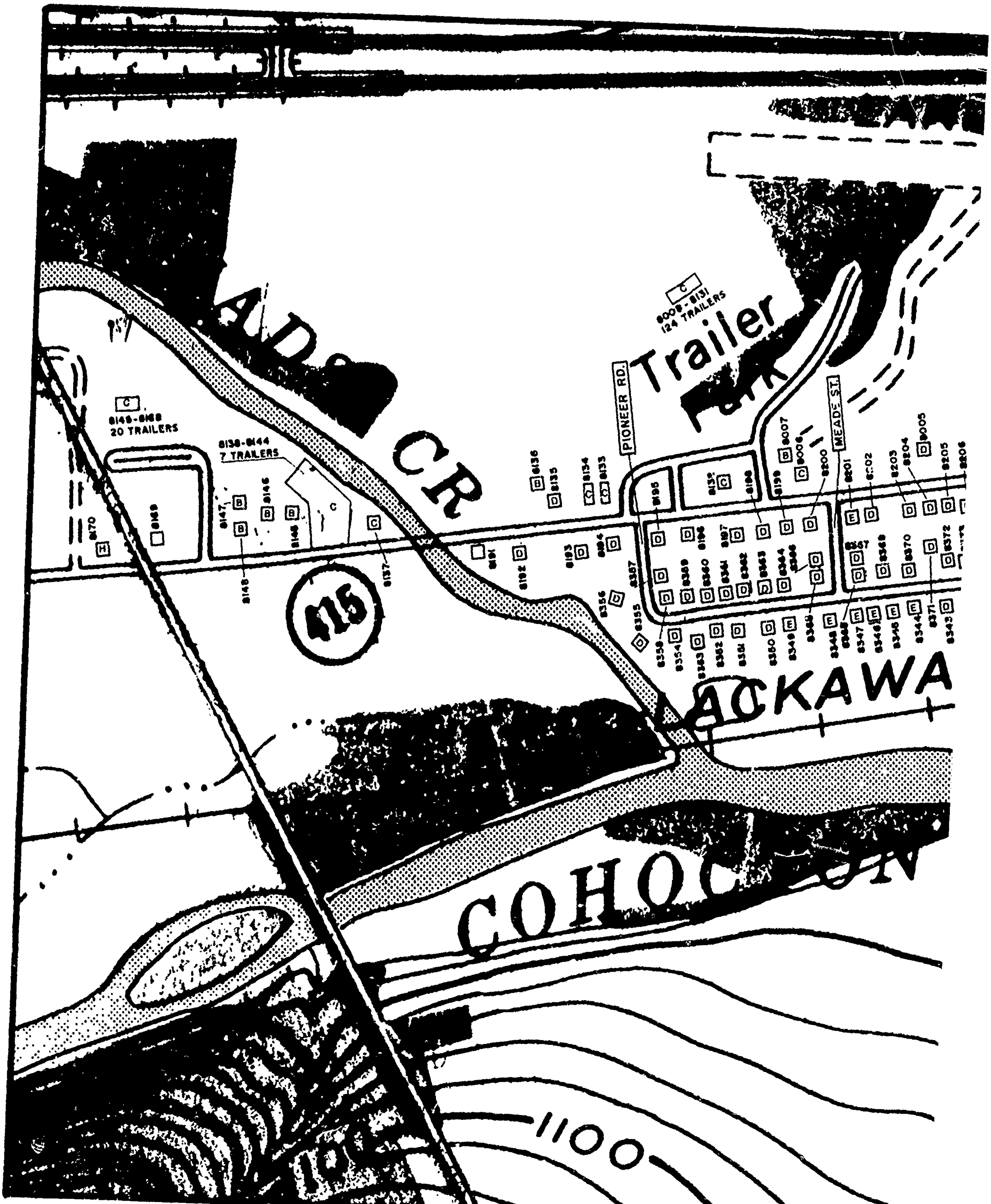
TION
EMOLISH
TRUCTURE
EMENT FLOODPROOF (2'-6')
LOODPROOF
FLOODPROOF

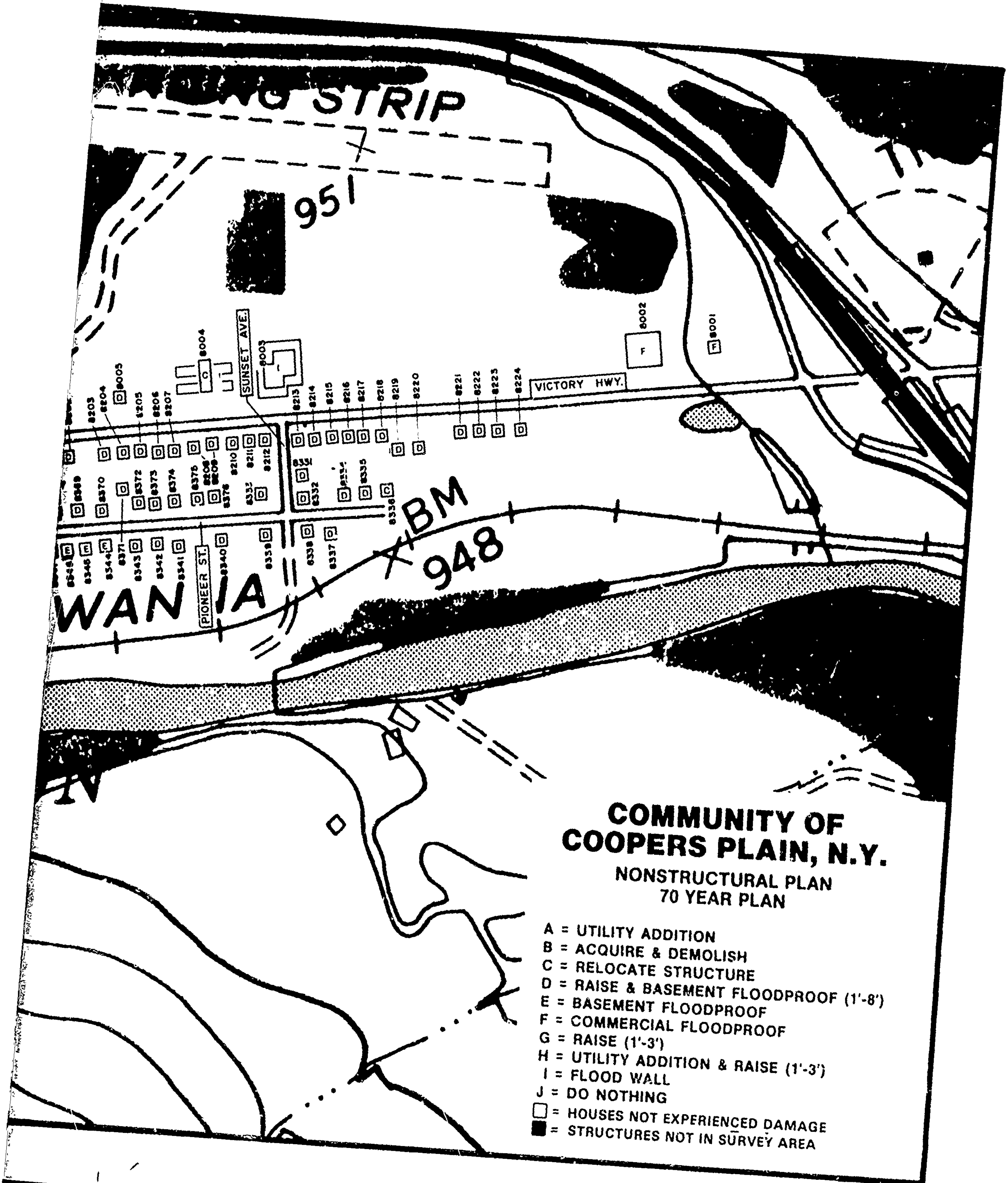
TION & RAISE (2'-8')

XPERIENCED DAMAGE



. 3 Plate 3a


8149-8168
20 TRAILERS
8138-8144
7 TRAILERS
8008-8131
124 TRAILERS
Trailer
PIONEER RD.
MEADE ST.
415
CR
1100


STRIP
951
SUNSET AVE.
VICTORY HWY.
PIONEER ST.
BM
948
WAN IA
COMMUNITY OF
COOPERS PLAIN, N.Y.
NONSTRUCTURAL PLAN
70 YEAR PLAN
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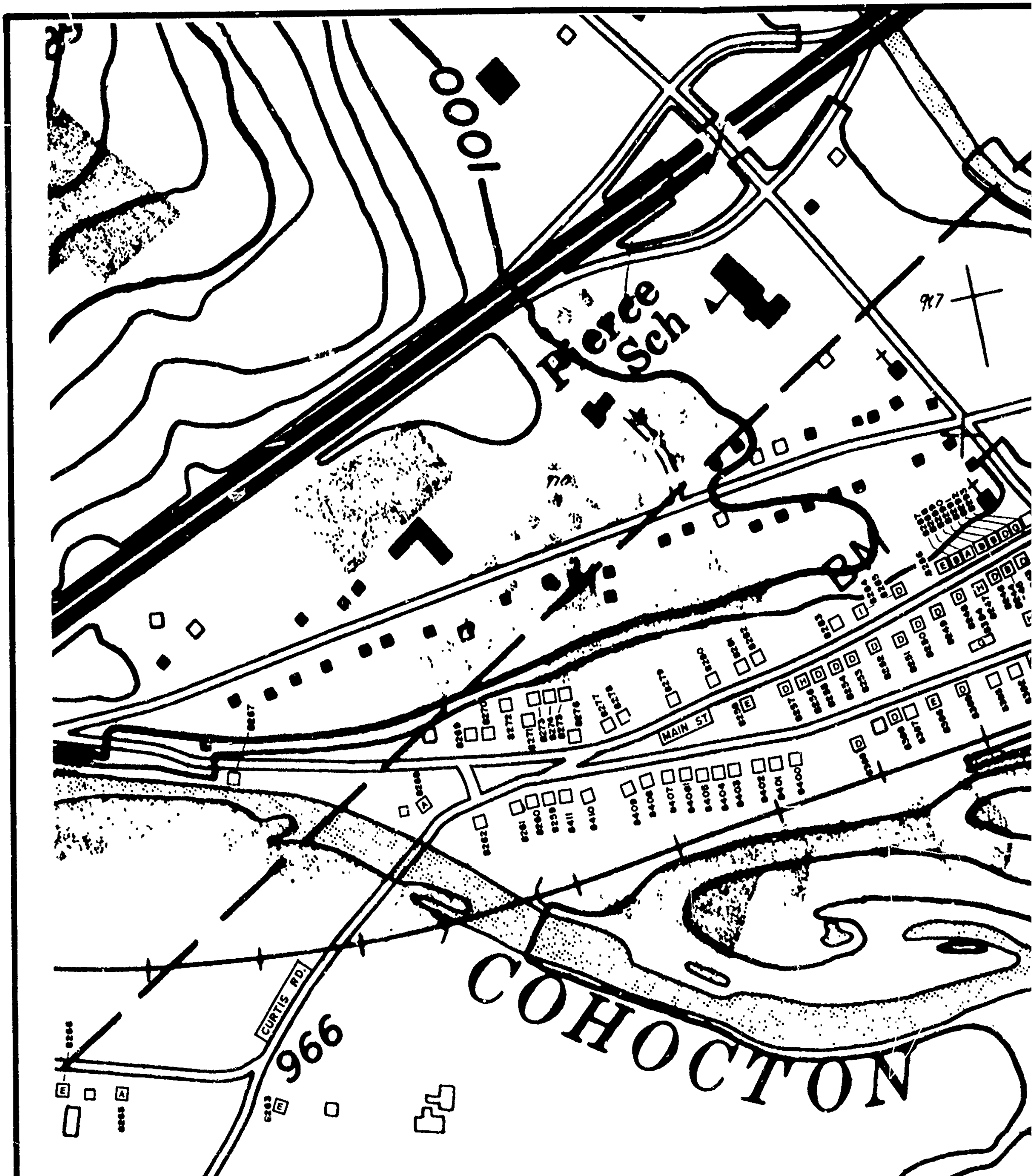
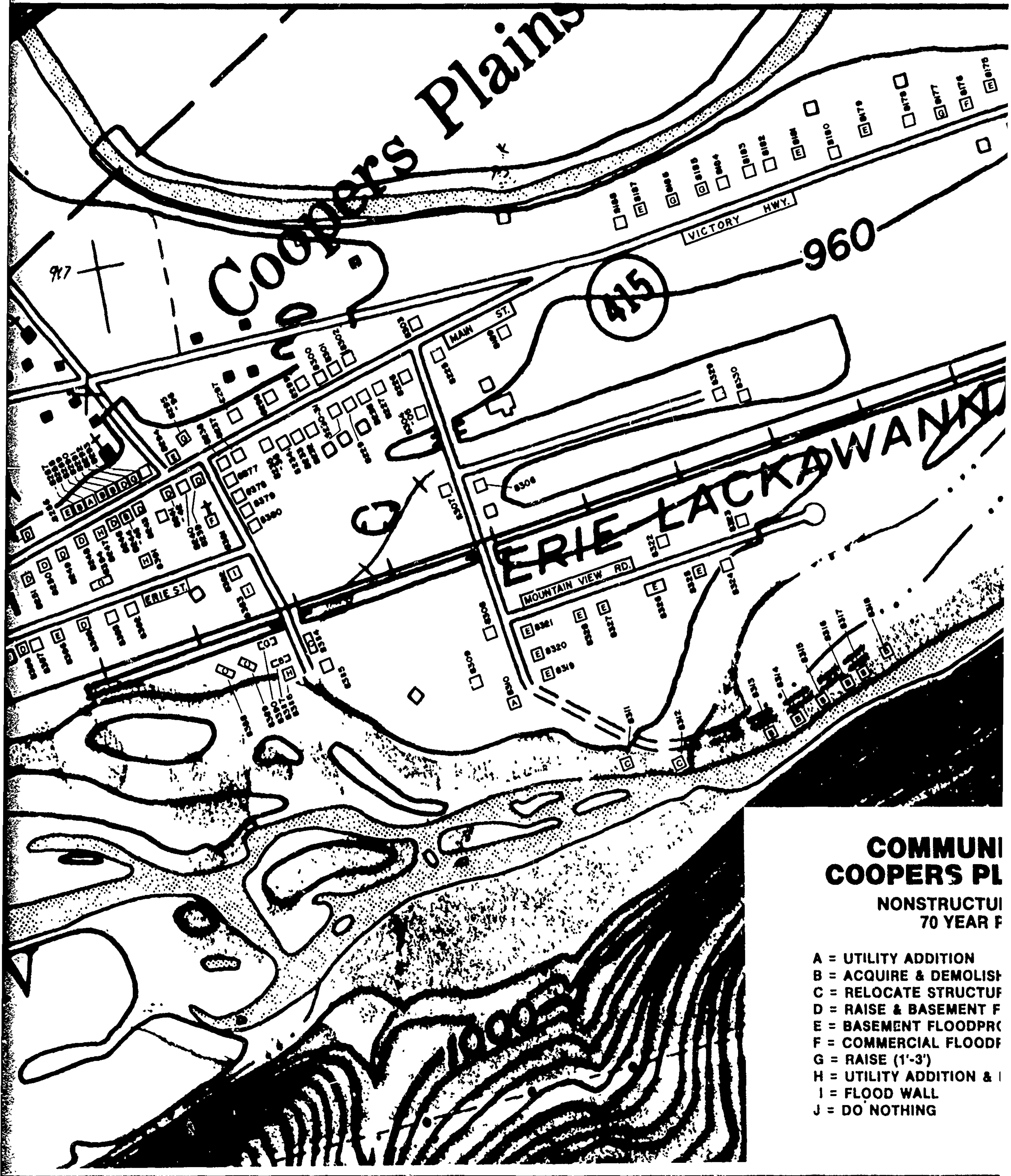
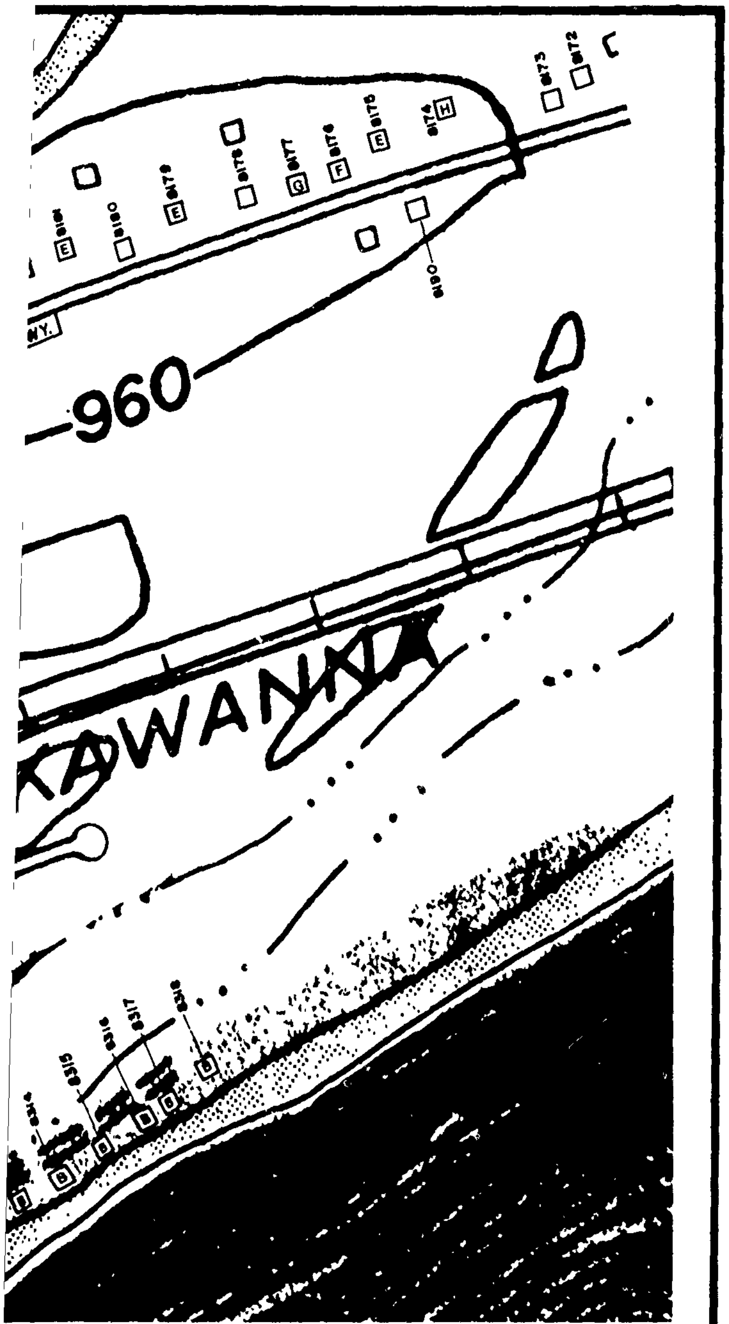
= STRUCTURES NOT IN SURVEY AREA

Plate 4a


1000
Pierce Sch
917
BM
MAIN ST
COHOCTON
966
CURTIS RD.
SMITH HILL RD.


Coopers Plains
VICTORY HWY.
960
415
MAIN ST.
ERIE LACKAWANN
MOUNTAIN VIEW RD.
ERIE ST.
1000
COMMUNI
COOPERS PL
NONSTRUCTUI
70 YEAR P
A = UTILITY ADDITION
B = ACQUIRE & DEMOLISH
C = RELOCATE STRUCTUF
D = RAISE & BASEMENT F
E = BASEMENT FLOODPR(
F = COMMERCIAL FLOODF
G = RAISE (1'-3')
H = UTILITY ADDITION & I
I = FLOOD WALL
J = DO NOTHING



COMMUNITY OF COOPERS PLAIN, N.Y.

NONSTRUCTURAL PLAN
70 YEAR PLAN

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